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STUDIES IN THE BRITISH FLORA.

By R. Lloyd Praeger, B.A.

II.—NOTES ON PLANT GEOGRAPHY.

It is a matter of every-day observation that the flora of two adjoining districts is never in all respects identical. Even if we carefully list the plants growing in one meadow, and compare it with the flora of an adjoining one, which, in respect of size, situation, soil and moisture appears precisely similarly situated, a certain diversity will be found. This arises from the fact that plants are so nicely adjusted to particular conditions of light, temperature, moisture and soil, that differences of these, almost inappreciable to our observation, will produce a slight balance in favour of one species as compared with another. In our meadow the ground is already densely overcrowded with plants, all of which have through long competition with their neighbours seized on every device and habit that will aid them in the struggle, and have established by force of arms their right to live. They all grow, so to speak, under high pressure, and the least change of outward conditions which tells in favour of one species is taken advantage of, and the less adapted plant goes under. So we can understand that any area of natural vegetation displays a complicated adjustment as regards its composition, and that the distribution of the component species is the inevitable result of a complex set of conditions, not the effect of chance.

In limited areas, moisture is the dominant factor of environment which determines the nature of the flora. If one meadow is marshy and another dry, a greater change of flora is produced by this variation than would result from any other physical difference. Soil is probably the next most important factor. When we come to deal with larger areas, climate begins to assume importance, till at length, in surveying the vegetation of the globe, we find climate the grand dominating influence which gives to countries and to continents their floral characteristics.

Of the four great Zones of Heat—Torrid or Intertropical, Warm-temperate, Cool-temperate, and Arctic-Alpine or Frigid—into which the earth's surface has been divided, our Islands lie in the Cool-temperate, with certain mountain-tops rising into the Arctic-Alpine. The general floral characteristics of this zone are the number of deciduous trees in proportion to evergreens, the number of herbaceous plants in proportion to trees, the gregarious or social character of many of the trees and shrubs, such as Pine, Oak, Gorse, Heather, which form vast colonies; and the abundance of greensward-producing grasses, and of terrestrial mosses and foliaceous lichens. Compared with the Tropics, we see in the increase of herbaceous plants and of deciduous trees, and of hardy low-growing plants of all kinds, adaptation for the successful weathering of our winter, a climatic change unknown in the Tropics. As compared with the vegetation of the Arctic-Alpine zone, the Cool-temperate zone is remarkable for its forest-trees, which are unsuited for the long, cold, stormy winters of high latitudes, and for its abundant annual plants, which under arctic conditions would not find, during the brief summer, a warm period sufficient for their growth, flowering and ripening of seed.

To the character of our climate and vegetation we owe one of the most delightful features of these countries. On account of the cessation of vegetative growth during our winter, the plants, unlike those of the Tropics, have to compress their period of flowering into a few summer months; and it is this, coupled with the gregarious or social character of the flora, that gives us our lovely English fields of Buttercups and Daisies, our glorious sheets of Golden Gorse and Purple Heather, which we would in vain attempt to match amid the heavy luxuriance of tropical vegetation.

While our British flora is thus relegated *in toto* to one of the great climatic floral divisions of the world, it is yet by no means homogeneous in character. Great Britain extends over some 700 miles north and south, a range of latitude sufficient to produce a considerable contrast between the flora of its opposite limits. A difference in annual temperature of over five degrees Fahrenheit exists between Caithness and Cornwall. But the actual conditions of temperature under which the British flora exists is far more varied than this. The requirements of a plant, as regards temperature, includes two important factors. It must have heat enough during summer to mature its seed, and the winter temperature must not be so low as to injure its tissues. The natural limits of a plant's range are usually fixed by one or other of these conditions, according as the constitution of the plant renders the question of summer maximum or winter minimum temperature the more important to it. The presence of large land areas conduces to a wide range of annual temperature—hot summers and cold winters—and in continental areas, therefore, the former class—heat-lovers,

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or *thermophiles*—find a suitable abode. An insular area, on the other hand, affected by the comparatively constant temperature of the surrounding ocean, exhibits a more equable climate, and here the second class—cold-fearers, or *frigofuges*—will congregate. While, in comparison with most parts of the European continent, the British

"Oh! to be in England
Now that April's there."

A typical Cool-temperate plant association—sward-forming grasses and low herbaceous plants, with groups of deciduous trees.

Isles possess an insular climate and a frigofuge flora, we may trace within our area considerable variation in this respect. Thus, the east of England, when compared with west, or much more with the west of Scotland or Ireland, has a continental climate. The annual range of temperature in the eastern counties of England is nearly double of that which obtains on the west coast of Ireland or the Outer Hebrides. And another question is bound up with this one. An insular climate is characterised by a moist atmosphere, the result of proximity to the sea; the continental climate by a drier atmosphere. Plants exhibit marked preferences in respect of aerial moisture, some favouring the dampness of an insular climate (hygrophiles), some the dryness of a continental (xerophiles). In the British Isles the thermophiles and xerophiles reside largely in the dry sunny eastern counties of England, while the frigofuge and hygrophilous species increase westward. These two groups, in fact, constitute in great measure H. C. Watson's "Germanic" and "Atlantic" types of distribution, the one characterised by its increase in the east, the other in the west of England. As we go northwards, likewise, into the colder and wetter regions of Scotland, the East-England group dies out, and is, in the extreme north and on the hills, at length replaced by various species of the Arctic-Alpine flora, which are essentially hygrophilous, though not frigofuge. These beautiful little northern and alpine plants are accustomed to a damp air, little sunlight, and a soil wet yet thoroughly drained—facts to be remembered in our attempts to grow them in our gardens.

But there are many species sufficiently plastic in their constitution to accommodate themselves to every variety of climate to be found in Britain. These widely distributed species constitute the "British type" of H. C. Watson. Some of them even range from the summit of the highest mountain of northern Scotland to sea level in the south of England. Most of them are characteristic members of the Cool-temperate flora.

When we come to consider the flora in greater detail, wide diversities of vegetation become at once apparent, and these, as already stated, are due largely to differences of moisture and soil. On a great turf-bog, for instance, where the supply of water is equal, and the soil everywhere the same, an almost absolute uniformity of flora exists, sometimes over thousands of acres. But usually our country exhibits considerable diversity of flora even within limited areas—the plant-associations characteristic of meadow, wood, marsh, stream, and gravelly or sandy wastes, compared with which agreeable variety the uniform, though often rich and beautiful flora of the veldt, prairie, savannah or steppe were monotonous. The effect of this diversity of conditions is that, from the point of view of any one of the constituent plant-groups, the country consists of a sprinkling or network of oases set in a desert—an archipelago, in fact. The major portion of the surface of our Islands consists of dry ground capable of producing crops of the plants useful to man, and has, as a matter of fact, been tilled for many hundred years. To the effect of tillage in destroying the natural plant-associations, reference was made in a previous article, where also the converse result of man's operations in introducing alien plants was enlarged upon (pp. 16-19 *supra*). But the bulk of the native plants of ordinary soils—*mesophytes* as they are called, from their requiring a moderate supply of water—still hold the ground in lessened numbers, and are widely spread, since the area suitable for their growth stretches continuously, forming, indeed, the sea in which the islands of very wet soils or very dry, of very limy soils or soils devoid of lime, are set. The Daisy, Bramble, Honeysuckle, and Ribwort Plantain, for instance, spread continuously over the surface of our country, and easily avoid the only barriers—the higher mountain-chains—which might impede their progress, by out-flanking them. It is different, however, in the case of hydrophytes and xerophytes—water plants and desert plants. Take the case of one of the common Pondweeds—say *Potamogeton lucens* or *rufescens*. These plants grow *in* water, and need this medium continually round them; their flowers alone rise above the surface, in order that the good offices of the wind may be utilized for effecting cross-fertilization. Lakes are their favourite habitat, they dislike flowing water, and more still rapid alterations of level, so that we seldom see them in rivers, or in dams or reservoirs. How are plants such as these to spread? The question may well give us pause. Their seeds* are too large and heavy to be borne by the wind, even if they ripened above the water, which they do not; and if entrusted to the stream which presumably drains

* I use the word "seed" in its popular sense—"a one-seeded unit of dispersal."

the lake, it is a question whether they would reach any other lake. The Bur-reed, so common in ponds and ditches, requires less deep and open water than the Pondweeds just mentioned; it is one of the plants of the fringe that separates the aerial from the subaquatic flora. Its seeds are likewise comparatively heavy, and not possessed of any special means of dispersal, yet it is a more widely-distributed plant than its companion the Reed-mace, which is furnished with innumerable light parachute-fruits, which it disperses annually over the country in tens of thousands, by the aid of the wind. The Yellow Iris has very heavy seeds, which cannot easily attain wide dispersal except by running water. But as a damp meadow provides a sufficiently wet substratum for the plant's growth, it has a wider range than species which need standing water. Its terrestrial habitat, too, brings it into contact with the larger animals, which in many ways help to scatter seed of all sorts. As to the water-plants before mentioned, aquatic birds perhaps assist dispersal more than any other agency. A great variety of seeds is mixed with the mud on the banks and in the beds of rivers and lakes, and many have been observed adhering with mud to the feet of wading birds. Other seeds have hard coats, which allow them to pass without injury through the alimentary canal of birds—digestion in birds being extremely rapid. That the seeds of the marsh and water plants *do* succeed in crossing the "deserts" of dry soil that hem them in on every hand is sufficiently evident; not a lake or pond but has its subaquatic association of Pondweeds, Water-Starworts, Water-Milfoils, Stoneworts, and so on, and its marginal fringe of Bur-reeds, Bulrushes, Reed-maces, and aquatic sedges and grasses. The "islands" of the opposite kind—very dry spots—have a more local development. They consist of sandy and gravelly wastes, and of rocks. As pointed out in a previous article, some of the rock plants have taken advantage of the wall-building proclivities of mankind to widely extend their domain; and mention has been also made of the fact that certain other xerophytes have followed the narrow strip of tenable ground supplied by the ballasting of railways right across an inhospitable clay-covered country. While the lighter soils and drier climate of the south and east of England permit of the growth of many such plants, their numbers decrease in the more rainy districts, and in Scotland and Ireland we find the xerophytes aggregated on the sands of the sea-coast.

When we come to examine the distribution of individual species, we find that while as regards *habitat* they consistently seek a due amount of water and a suitable soil and situation, yet their distribution is full of anomalies. What I mean is that while the occurrence of a certain plant points to the presence of certain conditions, the presence of certain conditions does not by any means necessarily involve the occurrence of the plant. This is where the historical element comes in. The flora as we find it now is the result of a long and eventful past. Species have arrived and departed, have advanced and retreated, in obedience to overmastering changes in climate and in the distribution of sea and land. That the bulk of our present flora migrated hither over a continuous land-surface at the close of the Glacial Epoch, from those southern parts of Europe which, though much colder than at present, were then free from ice, and able to support a Cool-temperate flora, we may safely assume. In colonising the country, the more plastic species spread over the land from end to end. The hardier plants followed the retreating ice northwards, and found a congenial home in Scotland, and northern England and Ireland. The sun-loving plants—perhaps for this very reason the latest comers—settled down in the warm and dry eastern counties of England. The remnants of the pre-existing flora, composed largely of Arctic-Alpine plants, retired in great part to the mountains. Some strange conditions appear to have existed along the old western sea-board, which allowed traces of the ancient pre-Glacial flora of southern plants to survive in Ireland and the south-west of England.

But even when the heterogeneous elements of the vegetation had settled down in accordance with the prevailing conditions, there was no pause in the ever-changing order of things.

> "Turn, turn, my wheel; all things must change
> To something new, to something strange,
> Nothing that is can pause or stay."

Some plants extended their domain; others sank in the grim struggle for existence. The older forms, presumably less suited to the new conditions, may well have found life difficult. Now, when a plant is increasing its area, or is at the high-water mark of its prosperity, we may expect to find its range continuous over the area which is suitable to its growth, like a pool of water which is enlarging. But if a plant's dominion is on the wane, and its area shrinking, it will retreat irregularly, clinging to its favourite habitats long after it has been swept away from the adjoining areas; its distribution will become discontinuous, like that of a pool of water which is drying up, and leaves for a while isolated wet patches in the spots best able to retain water. Thus it is that our arctic plants have shrunk back to the mountain-tops, where they now exist often in a perfectly isolated condition, and cut off from all communication with their former companions, imprisoned on other peaks. To quote equally conspicuous instances of *increasing* species is not easy, as the only plants of the kind which one can *see* increasing are weeds introduced by man, and consequently not subject to natural conditions; but a glance at the map in the January number of KNOWLEDGE, in which I illustrated the recent spread of three introduced railway colonists, will show that even each of these has a continuous range, and the appearance of having originated from a single centre of dispersal. Let us look more closely into some of these cases of discontinuous distribution. The most conspicuous instances belong to plants of distinctly northern or southern type. A number of species of the Arctic-Alpine group, left stranded on our mountain-tops as the cold of the Glacial Epoch retreated, are now represented by solitary plant-islets amid the sea of more southern forms, for instance: *Arabis alpina* (one spot in Skye); *Arenaria ciliata* (King's Mountain, co. Sligo); *A. uliginosa* (by one rill in Teesdale); *Saxifraga cernua* (Ben Lawers); *Mulgedium alpinum* (Forfar and Aberdeen); *Phyllodoce cærulea* (Sow of Athol); *Gentiana nivalis* (Breadalbane and Clova); *Pinguicula alpina* (Skye and Ross). These are all plants of the high north, or of the alpine portions of Europe.

The southern plants which form islands are often less rigidly restricted in their range, since they are low-level dwellers, and have better opportunity of spreading horizontally. *Euphorbia hiberna* and *Saxifraga umbrosa*, for instance, have a wide range along the western and southern coasts of Ireland, the latter showing its flexibility by ascending the mountains into the haunt of the alpines. *Pinguicula grandiflora* grows in profusion over great part of Cork and Kerry, an area of several thousand square miles, ascending like the last to a considerable elevation. All of these are southern forms. The most striking instances of these plant-islands, however, are those formed by species which have a wide range over the European continent, and might, therefore, be expected to find, so far as the all-important factor of climate is concerned, a suitable home in many parts of our islands. Yet remark-

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able cases of discontinuous distribution are not wanting. *Inula salicina*, for instance, is scattered over the shores and islands of Lough Derg in Ireland. Though widely spread in Europe and Asia, it is absent elsewhere in the British Islands, and furnishes a very remarkable example of an outlier of the kind referred to. *Carex Davalliana*, widely spread in Europe, had its only British station at Bath, but is now extinct there. *Carex Buxbaumii* should perhaps be reckoned with the relics of the Glacial flora; with a vast range abroad—Arctic and Alpine Europe, Asia, America, and Australia—it is represented in our islands by two patches, one in Scotland (Argyll), one in Ireland (Lough Neagh). Other examples of outlying stations of species widespread in Europe are afforded by *Dianthus cæsius* (Cheddar), *Selinum carvifolia* (Lincoln and Cambridge), *Peucedanum officinale* (Kent and Essex), *Cnicus tuberosus* (Wilts), *Phyteuma spicata* (Sussex), *Teucrium Botrys* (Surrey), *Herniaria ciliata* (Hants), *Epipogum aphyllum* (Hereford). In some of these instances, where the British habitats adjoin the Channel or the North Sea, they may perhaps be looked on as lying on the natural margin or climatic limit of the species; but in other cases the isolation of the stations appears to point to a shrinkage in the former area of distribution, and a distinct "island" formation.

It should be pointed out, however, that a plant-island may mean the very reverse of what has been exemplified above. A recent immigrant which has secured a hold in our country is bound, in the earlier stages of its history, to show a range resembling in its isolation that which has been described as characterizing the older members of the flora. To take an instance. The prickly North American knot-grass, *Polygonum sagittifolium*, has formed a flourishing colony in wild ground in Kerry. The North American orchid *Spiranthes Romanzoffiana*, which till quite recently was in Europe known only in this single station, has a similar colony in the adjoining county of Cork. Both are unknown in Great Britain and elsewhere in Europe. While the latter is regarded by botanists as an extremely ancient native, the former is looked on as probably a recent immigrant. The case of this *Polygonum* is a particularly difficult one. Usually, the plants introduced through man's agency show a decided aggregation about man's works—towns and harbours and cultivated land; while the old inhabitants, compared with whom the human tiller of the soil is a late comer, shrink from contact with man, and rejoice in thoroughly wild ground.

THE MIGRATIONS OF THE SKYLARK AND THE SWALLOW.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

IN KNOWLEDGE for January, 1901, I called attention to Mr. W. Eagle Clarke's summary of the migrations of the song thrush and white wagtail. The Report of the Migration Committee of the British Association, for 1901, contains summaries, by Mr. Clarke, of the migrational movements in the British Islands of the skylark and the swallow. The facts cleverly elicited and summed up by Mr. Clarke are so important and valuable that they should be widely known, and I have attempted below to extract the essence from Mr. Clarke's summaries. The summaries themselves, however, are so condensed in form that every word in them is valuable, and the complete paper should be read by those particularly interested in the subject. The committee announce that they are hopeful, in the course of two years more, of giving summaries of the movements of all the most representative species of migrants. It is difficult to realize the labour involved in unravelling from the mass of facts, collected by means of the schedules supplied to the lighthouse keepers, a coherent and orderly account of the migrations of any single species. But Mr. Clarke, on whom has fallen the entire burden of this work, by long labour and well-considered methods has been most successful, and is much to be congratulated on having traced and set forth very clearly and succinctly the intricate migrations of birds as observed in the British Islands.

THE SKYLARK.

The skylark is so common in England all the year round, that few people would suspect it of being a great wanderer. Yet as a migrant, no species makes so great a show in the returns of the light stations, and the complexity of its movements surpasses that of any other British bird. Mr. Clarke has separated these various movements as follows:—

In autumn—

(1) Certain skylarks which have nested here leave for the south.
(2) Others come from Central Europe to winter here.
(3) Others again arrive from Northern Europe to winter in our country.
(4) Others pass along our coasts on their way from Central Europe to Southern Europe.
(5) While others use our coasts as a highway on their journey from Northern to Southern Europe.

In the spring all these movements are reversed.

In winter, if there is severe weather, many birds leave us, and a number of more or less local movements take place.

To deal first with the home-bred birds. Although a great many of the skylarks which breed in the British Islands undoubtedly live with us all the year round, great numbers of them are strictly migratory. The emigration* of British-bred birds commences almost as soon as the nesting season is over, when skylarks begin to depart from the Hebrides. The migration continues to gain in strength as the autumn advances, and by September and October the skylarks which nested in Scotland and in many parts of Ireland, and the north of England, journey to the coasts in small bands, and make their way leisurely southward, to winter some in the southern and western counties of England, others on the Continent. During March and April these home-bred birds return.

Though a considerable number of skylarks thus leave us in autumn, their departure does not materially affect the abundance of the species, since prodigious numbers, from Central and Northern Europe, come to winter here. Indeed, so vast are these numbers, that in November, when most of the migration has ceased, our skylark population is undoubtedly at its maximum. It must be remembered, however, that at this time cold and want of food has not decimated them, and the skylark being regularly double-brooded, and often rearing even three broods in a season, increases in numbers in a marked degree in autumn from this cause.

The immigration of skylarks to the British Islands from Central Europe in the autumn is one of the most remarkable movements connected with the migrations of this bird or, perhaps, of any other British bird. It has been laid down as a principle of migration, that birds invariably move southward in autumn and northward in winter, but

* The terms "emigration" and "immigration" here used refer to the migration from and to the British Islands.

in this migration of the skylark from Central Europe, the birds proceed westward and possibly northward from their breeding grounds to reach their winter quarters. This immigration begins usually at the end of September, reaches enormous proportions in October, and practically ceases at the beginning of November. The birds strike our east coast in extended formation, reaching from the Humber, and even the Tees, to the south coast. Some idea of the magnitude of this influx may be gathered from the fact that in four years out of the eight covered by the enquiry, skylarks were observed to arrive by this route on over twenty days in each October.

An interesting fact in connection with the immigration from Central Europe is, that the passage across the North Sea is invariably performed in the day-time, the birds arriving from dawn until noon. Mr. Clarke does not make it quite clear whether the whole journey is sometimes performed in daylight or not, but since all important migrations are begun in the evening it seems that these birds have been travelling all night. Sometimes, however, they do not arrive before 3 p.m., and then the very remarkable, but not very uncommon, spectacle may be witnessed of two streams of birds of the same species migrating in opposite directions. For at this time in the afternoon our home-bred skylarks are starting on their journey to their winter quarters on the Continent, and their line of flight is actually crossed by the skylarks coming from Central Europe.

The coast, however, is not the ultimate destination of these travellers. On their arrival they disperse in various directions. Many intend to spend the winter somewhere in our islands, and of these some go inland and scatter over the eastern, southern and midland counties of England, but the majority proceed southward along the east coast and then westward along the south coast. Arrived at Land's End, many continue on a westerly and northerly course and so reach Ireland. Large numbers of these skylarks, however, are merely birds of passage with us, and on arriving in the west of England, they cross the channel at various points to the French coast.

The return of these birds to their breeding haunts in Central Europe in the spring comes very little under observation compared with the inflowing streams in autumn. The reasons for the want of observation are easily explained. To begin with, the number of skylarks has been enormously lessened by the ravages of winter as well as by the dangers of the long journeys. Then the birds set out from the coast in the evening, and on starting rise to such a height that they are seldom attracted by the lanterns of the lighthouses as they are when descending as they near the coast. But enough observations have been recorded to show that the return is made on much the same lines as the arrival, and that the movement begins in February and is continued until the end of March, the 28th being the latest day recorded.

There is yet another perfectly distinct migration of the skylark to be observed in Great Britain. This movement is concerned with the birds which summer in Scandinavia and seek our shores in autumn. The vanguard of these northern skylarks arrives very punctually in the first week in October, and the whole migration is usually compressed into four weeks, so that, as a rule, it ceases early in November. By this route, again, enormous numbers of skylarks reach our shores, but they strike the coast further north than those from Central Europe. Some pass down the coast, and leave us for warmer climes, but the majority disperse themselves over our islands, some reaching the Hebrides and replacing the home-bred birds which have already left their summer haunts. In mild seasons, during the third week in February, the birds begin to return to the north by the routes taken in autumn, and throughout March, especially after the middle of the month, there is much evidence of their departure.

The above-mentioned movements of the skylark (viz.: Emigration of home-bred birds; immigration of winter visitors and birds of passage from Central Europe; immigration of winter visitors and birds of passage from Northern Europe; and the return journeys) are those of a strictly migratory character which have been observed in the British Islands; but reference must be made to other movements, which depend entirely on the state of the weather. The skylark obtains the whole of its food on the ground, and hence a fall of snow or a prolonged frost drives it to change its quarters. Should the cold be of short duration, the movements of the skylarks are merely local, and the birds soon return to their former haunts. Should, however, the adverse conditions continue and become general, the movement becomes widespread and almost universal. "This effect," says Mr. Clarke, "is especially produced by great snowstorms, when the number of fugitives is so vast that people wonder where such prodigious multitudes can come from, as they throng towards the coast, and particularly the milder south-west coast of England . . . . though many undoubtedly cross the Channel and others proceed to Ireland."

THE SWALLOW.

The familiar Swallow may be taken as a typical example of a summer resident in the British Isles. Although its migrational movements in this country are much more simple and more easily followed than those of the skylark, it must be borne in mind that the birds which migrate to and from our shores are not all summer residents. Some of them are merely birds of passage passing through on the way to their breeding stations in Northern Europe. The winter quarters of the swallow are known to be in Africa, chiefly to the south of the Great Desert.

In dealing first with the spring immigration of swallows, which come to breed in this country, it should be stated that Mr. Clarke's material is so complete that he is able "to speak with authority as to the date of the swallow's successive arrivals on our shores, and also to trace with some degree of accuracy its gradual spreading over the country, which has hitherto been a *desideratum*."

A few solitary birds annually appear in March, but it is not until April that the vanguard of the host arrives. These early arrivals are either single birds or pairs. About ten days after the first comers, swallows appear in some numbers, and the influx proceeds throughout the rest of April and the first half of May. Those which arrive later are birds of passage proceeding to higher latitudes.

The first arrivals appear at different dates in different parts of our islands, and the appearance of swallows on the western seaboard, not only of the South of England but also of Scotland, is always some days in advance of their arrival on the east coast. Mr. Clarke has drawn up the following table of first arrivals: For south-western England, the beginning of the first week of April; for Ireland the end of that week; for south-eastern England, early in the second week; for south-western Scotland, the end of the same; for south-eastern Scotland, the middle of the third week; for northern Scotland, the fourth week; and lastly, it is not till the second week in May that the few swallows which resort to Orkney reach their destination.

As regards the manner in which the migration is performed, Mr. Clarke writes:—"Swallows are described as arriving on our southern shores during the day-time, chiefly in pairs, but sometimes as many as six or seven together, and flying low over the sea. The immigration

lasts most of the day; but they are also noted as coming in small parties, flock after flock, for several hours in succession, and unaccompanied by any other kind of birds."

In the last week of August there is a decided southward movement of the swallows in Scotland and the North of England, while in Ireland there is a movement to the coast in August. There is no evidence that these birds actually quit the country, and they probably wait some time in the southern counties before crossing the Channel. In September the southern movement becomes general throughout the country, and in the early days of that month the swallows begin to cross the Channel. The emigration reaches its maximum near the end of September, and by the middle of October it is practically over as far as Scotland and the north of England are concerned. But the swallows continue to leave the south of England until the middle of November, while stragglers are often seen later, especially in the south-west. A December swallow, however, is a very rare occurrence.

The swallows depart in much the same way as they come, except that they are, of course, more numerous, and they leave in perhaps larger bands. As far as it has been observed, the "emigration usually takes the form of the continuous passage of small parties, not exceeding a score, and as this may last for hours, vast numbers thus depart." Swallows have, however, been observed "on the south coast to assemble in thousands and fly away *en masse*, but this is only occasionally recorded." It seems that in some cases old and young birds migrate separately, and in others that they are proportionately mixed. The time of day at which they migrate is also varied. Swallows cross the English Channel by many routes, although there are certain much-used points of departure.

Little need be said about the swallows which visit us on their passages to and fro from the countries to the north and south of us. In the spring this migration sets in at the end of April, reaches its maximum about the middle of May, and may be prolonged until nearly the middle of June. Many of the earlier of these migrants reach our coasts in company with our own swallows. The migration is almost entirely confined to the east coast, and the North Sea is crossed before the northern limit of the mainland is reached. A few swallows may reach Northern Europe from the west of Scotland. After spending the summer in Scandinavia these swallows begin to return with their young along our east coasts on their way to Africa, in the middle of September. The passage is well maintained during the rest of the month, and is prolonged by a few birds to the first or second week in October. On their arrival on our shores these birds mix with our own swallows, and trace is lost of them, but it is more than likely that our milder climate induces many of them to linger, and if this is really the case, the lateness of migration on the east coast, as compared to that on the west coast, would be accounted for.

It will be seen from the foregoing brief summary, that Mr. Clarke has now put us into possession of a very complete history of the migrations of the skylark and the swallow, as observed in the British Islands. Beyond their intrinsic value and their great interest, such clear statements of facts will go far to solve the many important problems connected with the migrations of birds.

LIKE AND YET UNLIKE: THE FLYING-SQUIRRELS OF ASIA AND AFRICA.

By R. Lydekker.

Despite the repetition of the statement as to their essential structural difference in almost every work on popular natural history issued to the public, few persons, save those who have made anatomy a special study, can be induced to believe that swallows and swifts are not closely allied birds. And it may be presumed that an equal degree of incredulity will prevail in the minds of most people when they are told that the two animals whose portraits are given in the plate accompanying this article have no sort of intimate relationship, being in fact much more widely sundered from one another than are such apparently dissimilar creatures as a squirrel and a beaver. An instance of this incredulity has indeed been actually published with regard to the animal shown on the right side of the plate, which is one of the so-called African flying-squirrels, or, as they might be better termed, scale-tailed squirrels. Now this particular species of the group was sent home from Central Africa by Emin Pasha in the eighties, and described and figured under the name of *Anomalurus pusillus* by Mr. Thomas, of the British Museum, in 1887 and 1888. Three years later his figure (the one here reproduced) appeared in Major Casati's "Ten Years in Equatoria," with the following remarks:—

"The flying squirrel (*Mboma*) lives in the forests, almost always upon the branches of the trees, whence it throws itself, expanding the membrane which joins the feet to the body, like a parachute. The skin is used as an ornament. I think it is identical with one very common in the Island of Ceylon, which is almost tame."

The extraordinary misconception as to the affinities of the creature displayed in the last sentence of this quotation will be apparent when we say that the scale-tailed squirrels—whether furnished with a flying-membrane or not—are absolutely restricted to Equatorial Africa, where not a single representative of the true flying-squirrels of Asia and Europe exists.

The reason why these two very dissimilar groups of animals are regarded in popular estimation as closely allied is, of course, due to the fact that both are furnished with expansions of skin by means of which they are enabled to take flying leaps from bough to bough. Such flying-membranes are developed in very few mammals, and the popular idea is that the presence of such a membrane must necessarily imply intimate affinity between all the forms in which it occurs. Hence not only are the African flying scale-tailed squirrels associated with the typical flying-squirrels, but the still more widely-separated flying-phalangers of Australasia are likewise regarded as members of the same group.

In making such associations the public fail to recognise that similar structures may be produced in totally different groups of animals owing to their living under similar special conditions, or having peculiar habits of the same nature. In external appearance rodents belonging to different families, such as squirrels and dormice, may be very much alike; and if certain members of each group had acquired the same mode of life as the flying-squirrels, their similarity would probably have become still more noticeable. For unless the whole skeleton of the fore-limbs be so modified as to form a wing, as in bats, it is difficult to see how ordinary mammals could be endowed with the power of taking flying-leaps save by the development of an expanse of skin along the sides of the body in the manner which obtains in the true flying-squirrels, the scale-tailed flying-squirrels, the flying-phalangers, and, it may be added, the flying-lemurs.

The development of flying-membranes in all these four groups of mammals has, in fact, taken place quite independently, and affords an interesting example of what is known as parallelism in development. Such parallelisms are due, so to speak, to the poverty of possibilities in the way of modification of animal structures. As already

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A'.

B.

LIKE AND YET UNLIKE.

An Asiatic (A') and an African (B) Flying-Squirrel

(From Plates illustrating Papers by Mr. O. Thomas.)

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said, the simplest and most obvious way of endowing an ordinary four-limbed mammal with the power of taking flying-leaps is by the development of lateral expansions of skin. Similarly, the only easily conceivable method by which a primitive short-limbed and many-toed hoofed mammal could be converted into one cut out for speed, like a horse or a gazelle, is by reducing the number of the digits and increasing the length of the lower segments of the limbs. Accordingly, we find parallelism in this respect between the horses and the zebras on the one hand, and the gazelles, antelopes, and deer on the other.

But the parallelism is by no means exact in this latter case, as indeed would be naturally expected if the lines of evolution were distinct; and the structure of the lower portion of the limbs of a horse differs essentially from the same part in a gazelle.

Neither is the parallelism exact in the case of the two groups of flying-squirrels. In the flying-squirrels of Europe and Asia, such as the one depicted on the left side of the plate, the flying-membrane, or parachute, is merely a lateral expansion of the ordinary skin of the body, which extends outwards between the limbs and terminates at the wrist and ankle. In addition to the two lateral membranes, there is a narrow and inconspicuous one passing from each cheek along the front of the shoulder to the front of wrist; and another, at least in the larger forms, connecting the two hind-legs and involving the base of the tail.

In general characters the parachute of the scale-tailed flying-squirrels of Africa conforms to the above type; and a superficial observer might say that the two were in all respects similar. A closer examination will, however, reveal the fact that the parachute in this group is supported by a process of cartilage projecting like a yard-arm from the elbow and extending to the edge of the membrane. As this is present in all the flying scale-tails (as we may call them for short, especially as they have no right at all to the title of squirrels) and absent in all the true flying-squirrels, it evidently indicates an important difference between the two groups.

A further important distinction between them is afforded by the presence on the under surface of the basal portion of the tail of a series of overlapping horny scales, from which the African group takes both its popular title of scale-tail, and its scientific name of *Anomalurus*. Evidently these scales are intended to aid in supporting the animals as they climb the boughs or stems of trees, and are thus strictly analogous to the stiff tail-feathers of woodpeckers.

Another important difference between the two groups is to be found in the structure of the crowns of their cheek-teeth. In ordinary squirrels the grinding surfaces of these teeth are surmounted by simple tubercles, which in some cases may be elongated into ridges. And a similar type of tooth-structure obtains in most of the flying-squirrels of Europe and Asia, although in the species shown in the plate the structure has become somewhat more complicated owing to the taller crowns of these teeth. In the scale-tails, on the other hand, a totally different type of tooth-structure obtains, the crowns of the molars being divided by transverse folds of enamel, after a fashion recalling that which obtains in certain South American rodents.

To the anatomist these differences are sufficient to render it quite certain that the scale-tailed flying-squirrels are, at most, but very remotely connected with their non-scaled namesakes of the northern hemisphere. The non-scientific person might, however, say that the "yard-arm" in the parachute and the scales on the tail are features which have been developed concomitantly with the acquisition of the parachute itself in certain species of flying-squirrels, and that, like the differences in the structure of the teeth, are of no particular importance one way or the other in regard to the affinities of the animals in which they occur.

A few years ago it would have been impossible to produce absolutely decisive evidence as to the futility of such specious arguments. Recently, however, there has been discovered on the west coast of Africa—that home of strange and primitive types of animal life—a rodent looking not unlike a large dormouse, which is really the "grandfather" of all the flying scale-tails. For this creature (known as *Zenkerella*), although without a parachute, has scales on its tail like *Anomalurus*, and teeth of the same type as the latter. Whether it is the actual form from which the flying scale-tails are descended, or whether it is itself a descendant of such ancestral form, may be left an open question, as it is one of no practical importance. But it may be taken as certain that the flying scale-tails, of which, by the way, there are two distinct generic types (*Anomalurus* and *Idiurus*), are the specialised descendants of a creature closely allied to, if not identical with, *Zenkerella*. It may further be affirmed with certainty that the evolution of the flying from the non-flying scale-tails has taken place in Africa. Whether, however, *Zenkerella* itself is an aboriginal African type, or an immigrant into the dark continent from the north, is a question not easy to answer at the present time.

Although the flying-squirrels of Europe and Asia have been known from time immemorial, their pedigree is not so easy to trace as is that of the scale-tails. Probably they were evolved from non-flying squirrels at an earlier date than that at which *Anomalurus* branched off from *Zenkerella* (or its prototype), as they appear to be represented by teeth in some of the earlier Tertiary deposits of Europe. It is therefore quite probable that even the generic types from which they trace their descent have died out. Nevertheless, it may be considered practically certain that they are descendants more or less nearly allied to the true squirrels of the genus *Sciurus*. Their pedigree is therefore wholly distinct from that of their reputed cousins the scale-tailed flying-squirrels of Equatorial Africa.

In appearance the true flying-squirrels, of which there are three distinct generic types, are very similar to ordinary squirrels, as indeed they are in their habits; their long flying leaps, during which they half float in the air by the aid of the parachute, being only an extension of the bounds taken by the ordinary red squirrel in its passage from tree to tree. Many of them are even more beautifully coloured than ordinary squirrels. Compared with the latter, flying-squirrels are more strictly nocturnal animals; and their shrill scream is familiar to all travellers in the wooded districts of the Himalaya as they are attracted by the light of the camp-fire.

The smallest members of the group are the pigmy flying-squirrels, typified by *Sciuropterus volans* of Eastern Europe and Siberia, and represented in North America by the closely allied *S. volucella*. They are pretty little creatures, with soft velvety fur, and enormous staring black eyes. In all the pigmy flying-squirrels the membrane connecting the hind-legs and the base of the tail is absent; but, in compensation, the tail itself is broad, flat, and laterally expanded, so as to form an efficient aid in flight.

The typical and larger flying-squirrels, formerly known as *Pteromys* but now called *Petaurista*, are confined to Europe and Asia, having no transatlantic representative.

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Unlike that of the pigmy flying-squirrels, the tail of these rodents is cylindrical and comparatively thin, while, as already said, the parachute is fully developed between the hind legs.

In the last and finest representative of all the flying-squirrels—the species shown on the left side of the accompanying plate—the writer has a special personal interest. About the year 1878, when in Srinagar, Kashmir, he purchased the skin of a large flying-squirrel from a *chamra-walla* (tanner), who stated that it came from Astor or Gilgit, and that he had never previously seen its like. In due course this skin was brought to England, and converted into a perambulator-rug, in which capacity it was in use for several years, on one occasion narrowly escaping complete destruction by the jaws of a favourite pug-dog. At this period, it may be mentioned that the writer was less well acquainted with mammals, so far as their exteriors are concerned, than he is at the present day. And although he had a suspicion that the skin in question was peculiar, no steps were taken to ascertain whether this was really the case. One day, however, in 1888, when paying a visit to the Natural History Museum, he was shown a living flying-squirrel from Astor, remarkable for its dark colour and bushy tail, which was pronounced to represent a then unknown species. A brief inspection was sufficient to render it evident that the skin serving as a perambulator-rug belonged to the same species as the living animal, although a much larger and finer individual. It was soon after presented to the Museum, and described, in conjunction with the complete specimen, not only as the type of a new species, but of a new genus, under the title of *Eupetaurus cinereus*. Owing to the splendid development of the tail in the flat skin, the figure of which a reproduction is given on the left side of the accompanying plate was partly drawn from that specimen.

The main reason for making the woolly flying-squirrel (as, from the nature of its coat, it has been called) the type of a genus by itself is afforded by the characters of its cheek-teeth, which differ from those of other members of the group by their tall crowns and imperfectly developed roots. This character indicates greater specialisation than the ordinary flying-squirrels. Unfortunately little or nothing is known as to the life-history of this splendid representative of the flying-squirrels, but there is some reason to believe that it dwells, at least to a certain extent, among rocks, rather than in trees.

Although they do not properly come within the scope of the present article, a few words may be said with regard to the flying-phalangers (the flying-squirrels of the colonists) of Australia, since in one respect they present a curious analogy with the flying-squirrels of the Old World. It need hardly be said that these Australian flying-phalangers are true marsupials, with a dentition resembling that of the ordinary phalangers, or, as they are locally called, opossums. The larger flying-phalangers, which constitute the genus *Petaurus*, are characterized by the full development of the parachute and the rounded bushy tail. As in the case of the Asiatic flying-squirrels, we are unable to point out the non-volant type of phalanger from which they are descended.

On the other hand, the beautiful pigmy flying-phalanger (*Acrobates*), which differs from the larger forms by the scantier development of its parachute, as well as by its tail being formed after the type of a feather—that is to say being flattened, with a line of hair along each edge—is evidently descended from the non-flying feather-tailed phalanger *(Distœchurus)*, or the immediate ancestor of the latter. In this case, therefore, we have an exact parallelism to the descent of the flying representatives of the scale-tails from the non-flying *Zenkerella*.

THE LUCID STARS.

By J. E. Gore, F.R.A.S.

The term "lucid" has been applied to the stars visible to the naked eye, without optical aid of any kind.* Many people think that the number of stars visible in this way is very large. But in reality the number visible to the naked eye is comparatively small. Some persons are, of course, gifted with very keen eyesight—"miraculous vision" it is sometimes called—and can see more stars than others; but to average eyesight the number visible in this way, and which can be individually counted, is very limited. The famous Hipparchus formed a catalogue of stars in the year 127 B.C. This presumably contained all the most conspicuous stars he could see in his latitude, and it includes only 1025 stars. Al-Sufi, the Persian astronomer, in his "Description of the Fixed Stars," written in the tenth century, describes the positions of only 1018 stars, although he refers to a number of other faint stars, of which he does not record the exact places. Pliny thought that about 1600 stars were visible in the sky of Europe.

In modern times, however, a considerable number of fainter stars have been recorded as visible to the naked eye. The famous German astronomer, Heis, who had keen eyesight, records the positions of 3903 stars north of the Equator, and 1040 between the Equator and 20 degrees south declination, or a total of 4943 stars between the North Pole and 20 degrees south of the Equator. This would, I find, give a total of about 7366 stars for both hemispheres if the stars were equally distributed. Behrmann, in his Atlas of Southern Stars, between 20 degrees south declination and the South Pole, shows 2344 stars as visible to the naked eye. This would give a total of 7124 for both hemispheres. The actual number seen by Heis and Behrmann in both hemispheres is 4943 + 2344, or 7287 stars. The Belgian astronomer, Houzeau, published a catalogue and atlas of the stars in *both* hemispheres, made from his own observations in Jamaica and South America, and finds a total of 5719 stars in the whole sky. As all these observers had good eyesight, we may take a mean of the above results as the total number visible to the naked eye in the whole star sphere. This gives 6874 stars, or in round numbers we may say that there are about 7000 stars visible to average eyesight in both hemispheres. This gives, of course, about 3500 stars to one observer at the same time at any point on the earth's surface.

As the whole star sphere contains an area of 41,253 square degrees, we have an average of one star to six square degrees. In other words there is, *on an average*, one lucid star in a space equal to about thirty times the area covered by the full moon! This result may seem rather surprising considering the apparently large number of stars visible to the naked eye on a clear night, but the fact cannot be denied. The stars are not, of course, equally distributed over the surface of the sky, but are gathered together in some places, and sparsely scattered in others, and this may perhaps help to give the impression of a greater number than there really are.

That the stars are of various degrees of brightness was recognised by the ancient astronomers. Ptolemy divided them into six classes, the brightest being called first magnitude, those considerably fainter the second, those much fainter still the third, down to the sixth magnitude, which were supposed to be the faintest just visible to the naked eye on a clear moonless night. Ptolemy only recorded whole magnitudes, but Al-Sufi, in the tenth

* Except concave spectacles used by short-sighted persons.

century, divided these magnitudes, for the first time, into thirds. Thus a star slightly less than an average star of the second magnitude he called 2—3, that is nearer in brightness to 2 than to 3; one a little brighter than the third he recorded as 3—2, or nearer to 3 than to 2, and so on. This method has been followed by Argelander, Behrmann, Heis, and Houzeau, but in the photometric catalogues of Harvard, Oxford, and Potsdam, the magnitudes are measured in decimals of a degree. This has been found necessary for greater accuracy, as the heavens contain stars of all degrees of brightness.

The term "magnitude" means the ratio between the light of a star of a given magnitude and that of another exactly one magnitude fainter. This ratio has been variously estimated by different astronomers, and ranges from 2·155, found by Johnson in 1851, to 3·06, assumed by Pierce in 1878. The value now universally adopted by astronomers is 2·512 (of which the logarithm is 0·4). This number is nearly a mean of all the estimates made, and agrees with the value found by Pogson in 1854 by means of an oil flame, and by Rosen with a Zöllner photometer in 1870. It simply means that an average star of the first magnitude is 2·512 times the brightness of a star of the second magnitude; a star of the second, 2·512 times brighter than one of the third, and so on. This makes a star of the first magnitude just 100 times brighter than one of the sixth.

There are several stars brighter than an average star of the first magnitude, such as Aldebaran. These are Sirius, which is nearly 11 times brighter than Aldebaran (according to the revised measures at Harvard); Canopus, the second brightest star in the heavens, and about two magnitudes brighter than Aldebaran; Arcturus, Capella, Vega, Alpha Centauri, Rigel, Procyon, Alpha Eridani, Beta Centauri, and Alpha Orionis. Al-Sufi rated 13 stars of the first magnitude, visible at his station in Persia, and Halley enumerates 16 in the whole sky. According to the Harvard photometric measures, there are 13 stars in both hemispheres brighter than Aldebaran, which is rated 1·07.

As average stars of the different magnitudes the following may be taken as examples, derived from the Harvard measures: First magnitude, Aldebaran and Spica; second magnitude, β Aurigæ and β Canis Majoris; third magnitude, ι Aurigæ and β Ophiuchi; fourth magnitude, θ Herculis and ε Draconis; and fifth magnitude, ρ Ursæ Majoris and ω Sagittarii. Stars of about the sixth magnitude are, of course, numerous, and lie near the limit of naked-eye vision for average eyesight, although on clear moonless nights still fainter stars may be "glimpsed" by keen-eyed observers.

The stars have been divided into groups and constellations, now chiefly used for the purpose of reference, but in ancient times they were associated with the imaginary figures of men and animals, etc. The origin of these constellation figures is doubtful, but they are certainly of great antiquity. Ptolemy's constellations were 48 in number, but different writers from the first century B.C. give different numbers, ranging from 43 to 62. Bayer's Uranometria, published in 1603, contains 60, 12 new constellations in the Southern Hemisphere having been added by Theodorus to Ptolemy's original 48.

The figures representing the constellations were originally drawn on spheres, or celestial globes as they are now called. The ancient astronomers attributed the invention of the sphere to Atlas. It seems certain that a celestial sphere was constructed by Eudoxus in the fourth century B.C. Strabo speaks of one made by Krates about the year 130 B.C., and according to Ovid, Archimedes had constructed one at a considerably earlier period. None of these ancient spheres have been preserved. There is, however, in the Vatican a fragment in marble of a Greco-Egyptian planisphere, and a globe in the museum of Arolsen, but these are of much later date. Our knowledge of the original constellation figures is derived from the accounts given by Ptolemy and his successors, and from a few globes which only date back to the Arabian period of astronomy. Among the Arabian globes still existing the most famous is one made of copper, and preserved in the Borgia Museum at Velletri in Italy. It is supposed to have been made by a person called Caisar, who was executed by the Sultan of Eygpt in A.D. 1225. The most ancient of all is one discovered some years ago at Florence. It is supposed to date back to A.D. 1081, and to have been made by Meucci. There is also one in the Farnese Museum at Naples, made in A.D. 1225. Of modern celestial globes the oldest is one made by Jansson Blaeu in 1603. This gives all the constellations of the Southern Hemisphere as well as the Northern.

Ptolemy's figures of the constellations were restored by the famous painter Albert Durer, of Nüremberg, in 1515. The figures on modern globes and maps have been copied from this restoration. Durer's maps are now very rare.

In 1603 an atlas was published by Bayer. This was the first atlas to show the southern sky, and the first to designate the brightest stars by the letters of the Greek alphabet. Flamsteed published an atlas in 1729. Maps and catalogues of the lucid stars have been published in recent times by Argelander, Behrmann, Heis, Houzeau, Proctor, and others. Of these Heis' is, perhaps, the most reliable, at least so far as accurate star magnitudes are concerned. Houzeau shows *both* hemispheres, all the stars having been observed by himself in Jamaica and South America. Behrmann's maps are confined to the Southern Hemisphere, between the South Pole and 20 degrees south of the Equator. The maps of the *Uranometria Argentina* made at Cordoba in the Argentine Republic, show all the southern stars to the 7th magnitude, but many of these are beyond the reach of ordinary eyesight.

It is a well-known fact that the planets Venus and Jupiter are bright enough to form shadows of objects on a white background. It has also been found that the brightest stars, especially Sirius, are sufficiently brilliant to cast shadows. Kepler stated that a shadow was formed by even Spica, but I am not aware that this has been confirmed by modern observations.

There are some remarkable collections or clusters of stars visible to the naked eye, of these the Pleiades are probably the best known. To ordinary eyesight 6 stars are visible, but Möstlin, Kepler's tutor, is said to have seen 14 with the naked eye, and some observers in modern times have seen 11 or 12. Other naked-eye clusters are the Hyades in Taurus, called *Palilicium* by Halley, and the Præsepe, or Bee-Hive in Cancer. Of larger groups, the Plough or Great Bear, Cassiopeia's Chair, and Orion are probably known to most people.

Many of the lucid stars are double, that is, consist of two components, but most of these are only visible in powerful telescopes. There are, however, a few objects visible to the naked eye as double, and these have been called "naked-eye doubles," although not strictly double in the correct sense of the term. Ptolemy applied the term double to the star ν Sagittarii, which consists of two stars separated by a distance of fourteen minutes of arc, or about half the apparent diameter of the moon. According to Riccioli, Van der Hove saw two naked-eye doubles, one in Capricornus, 5 to 5½ minutes distant, and the other in the Hyades, 4⅓ or 5 minutes apart. The one in Capricornus was probably α, and the one in the Hyades θ Tauri. The middle star in the tail of the Great Bear, or handle of the Plough, has near it a small star, Alcor,

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which to many eyes is distinctly visible without optical aid. The famous Belgian astronomer, Houzeau, who seems to have had excellent sight, saw the star κ Tauri double, and 51 and 56 Tauri separated, also ι Orionis, and others.

Many of the stars are variable in their light, and several hundred of these curious and interesting objects are now known to astronomers. In a few of these the light changes may be followed with the naked eye. It is an interesting question whether any of the lucid stars have disappeared or changed in brightness since the early ages of astronomical observations. Al-Sufi failed to find seven of Ptolemy's stars, and Ulugh Beigh, comparing his observations with the catalogues of Ptolemy and Al-Sufi, announced twelve cases of supposed disappearance. Some of these may, however, be due to errors of observation. Montanari, writing in 1672, mentions two stars as having disappeared, namely β and γ of the constellation Argo, but these stars are now visible in the positions originally assigned to them.

In a careful examination of Al-Sufi's description of the stars written in the tenth century, and a comparison with modern estimates and measures, I have found several very interesting cases of apparent change in the brightness of the lucid stars. Al-Sufi was an excellent and careful observer, and as a rule his estimates agree well with modern observations. We can therefore place considerable reliance on his estimates of star magnitudes. "The Story of Theta Eridani" has been well told by Dr. Anderson in Knowledge for July, 1893, and there seems to be no doubt that this southern star, which is now only of the third magnitude, was a bright star of the first magnitude in Al-Sufi's time! The following are other interesting cases of apparent change which I have met with in my examination of Al-Sufi's work. The Pole Star was rated third magnitude by both Ptolemy and Al-Sufi, but it is now of the second magnitude, or a little less. The star γ Geminorum was rated third magnitude by Ptolemy and Al-Sufi, or equal to δ Geminorum, but γ is now of the second magnitude, and its great superiority in brightness over δ is noticeable at a glance. Another interesting case is that of ζ and o Persei, two stars which lie near each other, about seven degrees north of the Pleiades. Al-Sufi distinctly describes these stars as *both* of the 3—4 magnitude; but Argelander, Heis, and the photometric measures at Harvard agree in making ζ about one magnitude brighter than o. The stars being close are easily compared, and their present great difference in brightness is very noticeable. This is one of the most remarkable cases I have met with in Al-Sufi's work, and strongly suggests variation in o, as ζ is still about the same brightness as Al-Sufi made it. The identity of the stars is beyond all doubt, as Al-Sufi describes their positions very clearly, and says there is no star between them and the Pleiades, a remark which is quite correct for the naked eye. The remarkable decrease in brightness of β Leonis (Denebola) since Al-Sufi's time has been considered in my paper on "Some Suspected Variable Stars" (Knowledge, August, 1899). That it was a bright star of the first magnitude is fully proved by the observations of Al-Sufi and Tycho Brahe. These were careful and accurate observers, and they could not have been mistaken about a star of the first magnitude. β Leonis is now fainter than an average star of the second magnitude, and there can be no reasonable doubt that it has faded considerably since the tenth century.

There are some other discrepancies between Al-Sufi's observations and modern estimates, but the above are perhaps the most remarkable. With reference to lucid stars not mentioned by Al-Sufi, he has not I think omitted any star brighter than the fourth magnitude in that portion of the sky visible from his station. There are, however, a number of stars between the fourth and sixth magnitude which he does not mention. Of these the brightest seem to be ε Aquilæ, ρ and μ Cygni, and ζ Coronæ Borealis.

With reference to the distribution of the lucid stars in the sky there seems to be a well-marked tendency to congregate on the Milky Way. It is a remarkable fact that of the 15 brightest stars in the heavens, no less than 11 lie on or near the Milky Way, although the space covered by the Galaxy does not exceed one-fifth or one-sixth of the whole sky. From a careful enumeration of the stars in or near the Milky Way which I made some years ago, I found that of stars brighter than the fourth magnitude there are 118 on the Milky Way out of a total of 392, or about 30 per cent. From the Southern catalogue known as the *Uranometria Argentina*, Colonel Markwick, F.R.A.S., found 121 out of 228 stars to fourth magnitude, or a percentage of 53 per cent. These results seem to show some intimate relation between the lucid stars and the Galaxy.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

XI.—MORNING AND EVENING STARS.

It is one of the necessary penalties of the modern tendency towards city life that we are dissociated more and more from that close intercourse with nature which was open to our forefathers. How few of us ever care to watch that great spectacle which was to them so full of wonder and of awe, the silent, ceaseless procession of the starry heavens! It was not merely the sight of the thousand flashing gems of the midnight sky that impressed them, or their differences of colour and lustre, or the weird manner in which they were distributed; there was something more striking than all this, and that was their ceaseless movement. There was the wonder; that motion was so stately, so regular, so unceasing. "Without rest, without haste" they moved; no star ever left its appointed place in the celestial host, nor ever strayed from its appointed path. It was a nightly miracle, a miracle both of order and power. The thoughts to which it gave rise lay at the root of many an ancient myth, and inspired many a poetic outburst, chief amongst which stands the grand 19th Psalm. Nor, though the secret of that regular motion is understood to-day, is the sight of the movement of the vast cosmical machine in the least less impressive even now to any mind that can rise to some slight realisation of its true meaning.

But the observers of those early ages had other thoughts beside those of awe and wonder as they contemplated the nightly march of the heavenly host; there came a time when they had familiarised themselves with the different stellar groupings, and they saw that different constellations ruled the night watches at different seasons of the year.

After a long night watch in which the stately march of the heavenly host has been followed hour after hour, some stars moving round the pole in narrow circles, others passing out of view in the west, whilst new ones are ever mounting upward from the under world in the east, there comes a time when a change begins to be perceptible in the latter quarter. Little by little the eastern sky begins to brighten and the stars to pale, and now perchance it may be that a star more magnificent than any that has shone the long night through, comes upward, queen of the night, as the night is coming to an end. As it rises

higher, so the glow in the east becomes brighter, and the fainter stars die out, until at length all have disappeared in the increasing daylight and the sun itself arises, the bright herald which preceded it being the only one of all the starry company that remains visible till the sun's appearance.

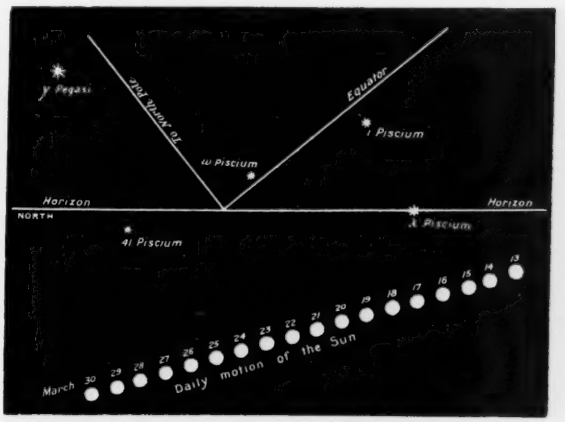
The planet Venus is the only object that in this completest manner can act as the forerunner of the sun, and it rightly, at such seasons, has a special claim to the title of the "Morning Star." But it is only now and then that Venus is so placed as thus to act as the solar herald. At other times the *rôle* has to be filled by stars of a meaner rank. But it is well worth noting what stars are the last to rise before the dawn drowns them with its growing light. The next morning it will be found that those same stars are visible just a little longer, and the next morning longer still, and so on, until some other star shows itself as the one to climb up from the eastern horizon just before the opening daylight becomes strong enough to overcome its shining.

Such stars are each in their turn "morning stars," and their first appearance in the faint dawn-glow of the east before sunrise is the "heliacal rising" which was made much of by ancient astronomers and poets. Not without reason, for it is an observation of very considerable exactness, and one which requires absolutely no instrument; not even the simple one of an obelisk or an upright spear, still less of the solid masonry of a "solstitial" or "equinoctial temple," or the huge trilithons of a Stonehenge. And it fixes the return of the sun to the same part of the heavens at the end of a year quite as exactly as those more cumbrous contrivances could do, if indeed they ever were used for such a purpose.

Corresponding to the "morning stars" are the "evening stars," the stars which are seen in the western twilight just before they set; the gathering darkness permitting them to be just glimpsed for a minute or two before they follow the departing sun down to the under world. This constitutes their "heliacal setting," and its observation supplements that of the "heliacal rising."

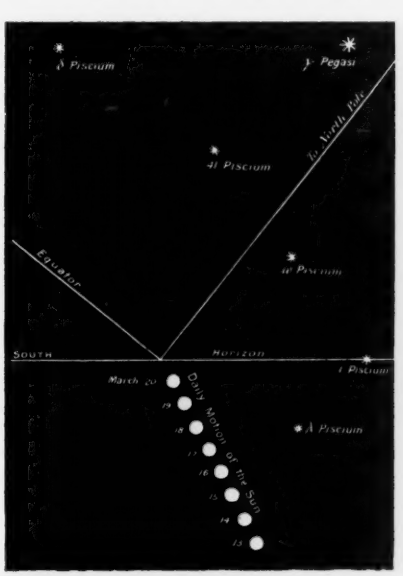
All stars are not by any means equally suitable for observation of their heliacal risings and settings. It is of course clear to begin with that the circumpolar stars, the stars which never set, are quite useless in such a connection. Nor are the stars in the extreme south, which only rise at the best a few degrees above the horizon, and only remain visible a very few hours, well suited for the work. The best stars are those which are not situated at any very great distance from the equator, either north or south, but which lie between the tropics of Cancer and Capricorn. Rigel, Sirius, Procyon, Arcturus, Alpha Serpentis, Alpha Ophiuchi are fairly well placed for observation in England, both at rising and setting, but as a general rule we may take it that the time of the spring equinox is the best for observing heliacal settings, and that of the autumnal for observing heliacal risings. The reason of this will be seen at once from the accompanying diagram, which represents the effect of the sun's motion in declination at setting, at the spring equinox; at the autumnal equinox the conditions are, of course, exactly reversed.

If the sun moved always in the equator, then a star which rose on one day at precisely the same time as the sun would rise about 4 minutes earlier than the sun on the next, and so on day by day. But at the time of the spring equinox, the sun is moving northwards at the rate of about 24 minutes of declination every day. Consequently the sun rises about $2\frac{1}{3}$ minutes earlier every day, and the stars which rise at dawn only gain therefore upon the sun 4 m. $- 2\frac{1}{3}$ m.; that is to say, $1\frac{2}{3}$ minutes. If the star is north of the equator, the sun is also coming nearer to it day by day, and hence that region of the sky becomes brighter and brighter at dawn. The result is that there may readily be a good deal of uncertainty about the determination of the day of the heliacal rising of such a star under these conditions. For the setting, the condi-



Positions of the Sun below the East horizon, near the Spring Equinox, at the rising of λ Piscium.

tions are reversed. If the sun were always in the equator, a star which set with the sun one day would set 4 minutes before it the next, and so on day by day. But since the sun is moving northward at the spring equinox, it sets about $1\frac{2}{3}$ minutes later each day, and the star therefore would set before the sun 4 m. $+ 1\frac{2}{3}$ m., or $5\frac{2}{3}$ minutes the



Positions of the Sun below the West horizon, near the Spring Equinox, at the setting of ι Piscium.

next night, and so on night after night. If the star was south of the equator, the sun would be moving away from it in declination, and under these circumstances we should get the sharpest determination of the date of heliacal setting. So the autumnal equinox gives the best opportunity for determining heliacal risings, specially for stars

north of the equator, and the worst time for observing heliacal settings, especially for stars south of the equator.

It follows from these considerations that the Pleiades, in spite of the frequent reference to their heliacal rising in classical poetry, were not well placed for this observation, for during the 5000 years that astronomy has been in active operation as a science, they were never so far from the vernal equinox as at present. It must, however, be borne in mind that the nearer to the equator the place of observation, the more exactly could the observation of heliacal rising be made. For the nearer the equator is approached, the more nearly are the apparent paths of the sun and stars perpendicular to the horizon. They, therefore, seem to rise in the sky much more sharply, and dawn and twilight last for a much shorter space of time. A similar remark applies in its degree to Sirius, which, 5000 years ago, would have been by no means a very good star to observe at heliacal rising here in England. But the land where Sirius was made much of for this purpose was Egypt, the most southern of all the ancient civilisations, and in that marvellous climate the star may often be seen now to rise sheer from the waters of the Red Sea. Under such circumstances the return of the year could be fixed with all desired exactness by the rising of Sirius, even when it was on the vernal colure.

There is a great interest for those who care to try to enter into the thoughts and conditions of the past in repeating for oneself the very observations which were so all-important thousands of years ago. And there is a real value in repeating them to-day. If three or four observers were independently to observe the heliacal risings and settings of some two dozen zodiacal stars for three or four years, we should gain a great deal of needed information as to the actual amount of precision of which the method is capable, and some needed light would be thrown upon its practical efficiency. But more than this, the work would prove very effective in teaching the observer to pick up quickly minute points of light in a bright sky. This training would be found afterwards of great value in more ambitious fields of astronomy. The variable star observer would find it of use in enabling him to discount the effect of bright moonlight on his observations; the double star observer would find his eye quickened to detect a faint companion in the glare which a bright star gives in the field of a great refractor.

But more than this, the work affords a chance—a rare one it must be admitted, but a chance not to be despised—of making a discovery of a most interesting kind. Occasionally comets passing through our system so approach us as not to be seen until they are close to the sun, and these are usually comets of exceptional interest, both from the character of their orbits and from their physical behaviour. Such objects the persistent observer of heliacal risings and settings is—from the nature of his work, and from the special acuteness in detecting objects in the twilight sky which it will have given to him—the most likely to be the first to discover. The great comet of the autumn of 1882, for instance, was first seen at sundown, the great southern comet of 1901 was detected just before sunrise; in both cases only a very short time before the comet passed into conjunction with the sun, and was temporarily lost to view. In both cases a regular "heliacal" observer would have stood a good chance of being two or three days ahead of anyone else in the discovery, to the gain of his own reputation and of astronomical science.

The three stars mentioned earlier, Sirius, Procyon and Rigel, may be observed to rise during the latter half of August; their settings fall in April and May. They are thus emphatically winter stars, Rigel coming to opposition on December 11th, Sirius on December 31st, and Procyon on January 12th. In the case of these stars, the opposition falls nearly midway between the date of rising and that of setting. Not so with stars near the equinoctial colures. Thus Spica rises at the end of October, comes to opposition on April 12, and sets in the middle of August. Hamal, on the other hand, rises near the end of May, comes to opposition on October 26, and sets in the middle of April. The Pleiades, too, which Hesiod reports as being invisible for forty days, are now invisible here in England for over sixty, from the end of April to the beginning of July, but the date of conjunction does not fall in the middle of this period but on May 19.

A very interesting side question would probably arise in the course of the systematic observation of heliacal phenomena, and that is the influence of colour on the visibility of stars of a given brightness in a bright sky. Orion and the neighbourhood are particularly rich in stars suitable for such a comparison. The orange tint of Betelgeux, the golden colour of Aldebaran, the slight suspicion of green about Bellatrix, the steel-blue of Alnath and of the giant Sirius, the white of Procyon, and the contrast which is so obvious between the tints of Castor and Pollux, afford ample materials for a very delicate and interesting research, and one which it still remains to make.

Stars for Heliacal Observation.

At Setting.	At Rising.
February—ϵ Pegasi, *Enif.*	August—β Orionis, *Rigel.*
March—α Pegasi, *Markab.*	α Canis Minoris, *Procyon.*
γ Pegasi, *Algenib.*	α Canis Majoris, *Sirius.*
α Piscium, *Okda.*	α Cancri.
April—α Arietis, *Hamal.*	September—α Leonis, *Regulus.*
β Orionis, *Rigel.*	β Leonis, *Denebola.*
η Tauri, *Alcyone.*	October—α Bootis, *Arcturus.*
May—α Canis Majoris, *Sirius.*	α Virginis, *Spica.*
α Tauri, *Aldebaran.*	November—α Serpentis, *Unuk.*
α Canis Minoris, *Procyon.*	α Ophiuchi, *Rasalague.*

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By Cecil Jackson.

II.—THE SUN.

Before treating of the sun itself, it will be desirable to consider the methods of observing it. For a small pocket telescope a cap containing a piece of very dark green glass will answer well. The glass should be so dark that the outlines of buildings are invisible through it when it is held up to the eye. A small telescope requires as dark a glass as a large one. Do not on any account be persuaded into having a light sun-glass on any telescope, however small, as the use of such a glass is very trying to the eye, except in a smoky or dull atmosphere.

Another way of viewing the sun is to fix a piece of paper in the sunshine, with the sun shining squarely on it. The paper may be pinned to a board, and the board reared up on a chair in such a way that the pins, if truly perpendicular to its surface, cast no shadow on the paper. Stand facing the paper, and hold the telescope—drawn out to its full length—with its eye-end a few inches away from the paper, so that a circular shadow is cast, in which case the telescope

is pointing at the sun, and a bright patch of light will appear on the paper. Slide the eye-tube of the telescope inwards until the patch of light has a sharp outline, and if there are any large spots upon the sun they will appear in the Solar image cast on the paper. When once the sun's image has been thrown on the paper, the telescope may be grasped by the left hand in such a way as to cast a margin of shadow around the image of the sun, or a cardboard disc may be fitted round the telescope tube for the same purpose. This will make the Solar image appear more pronounced.

More detail can, however, be seen by using a dark glass, and looking directly through the telescope at the sun. On a telescope not exceeding two inches in aperture there is no fear of the glass cracking, especially if the sun is not observed when high up in the sky, as it is at noon in summer, for example. In observing the sun when high up, it is a good plan to turn the telescope aside every few seconds so as to prevent the dark glass from becoming hot.

I shall now begin to describe the details of the sun as seen in the telescope.

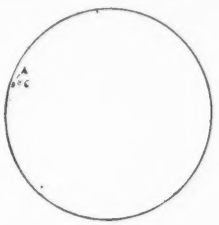


FIG. 4.

Fig. 4 represents the sun as seen at about 1h. 1m. p.m., June 24, 1899. A represents white marking seen near the sun's limb. B is a small spot. C is a large spot, surrounded by a grey border called a "penumbra" to distinguish it from the dark centre or "umbra." My $1\frac{5}{8}$-inch telescope with its own terrestrial eye-piece was used in making this observation. The pancratic draw was set to the power 30 line, so as to give a magnifying power of 30 diameters.

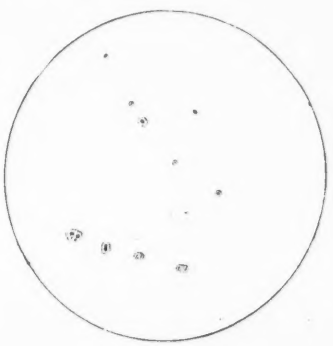


FIG. 5.

Fig. 5 represents the sun as seen on Aug. 5, 1893. Power 35 on the $1\frac{5}{8}$-inch telescope used. Time, about 4h. 9m. p.m. This picture gives an idea of the sun's appearance when largely spotted. As an instance of the difference in the number of days on which no spots are observed on the sun in different years, I may mention that I observed no spots on the sun on eight occasions in 1898, whilst in 1899 the days on which no spots were observed were about thirty-two.

FIG. 6.

Fig. 6 represents the sun as seen with a 1-inch pocket telescope at about 2h. 41m. p.m., Friday, Oct. 28, 1898. A dark glass was, of course, used on the telescope. On very clear days the sun may be seen, if a 2-inch telescope is used, to have a curdled appearance. I have sometimes seen this appearance with my $1\frac{5}{8}$-inch telescope. Tapping the telescope with the fingers, or moving it backwards and forwards may assist to make the curdling visible.

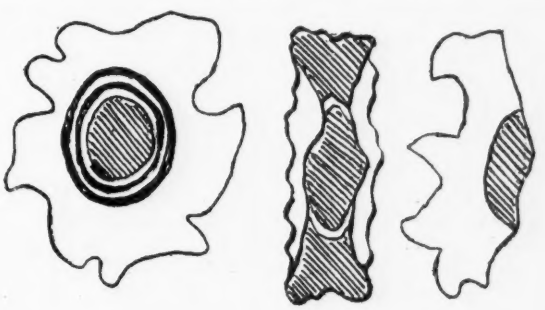
Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE FLIGHT OF A HAILSTONE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In reference to the interesting paper on "The Flight of a Hailstone," in the February number of KNOWLEDGE, I venture to send you the enclosed sketches of some hailstones which fell here on June 13th, 1900. They fell in large numbers at the end of a very severe thunderstorm. The area over which they fell was limited to a few miles radius. In form they resembled a cart-wheel, being thickest at the circumference. The alternate clear and opaque rings were very distinctly marked. The largest measured one and a half inches in diameter, and the weight, after the stones had been lying, perhaps, a quarter of an hour on the ground, was one-third of an ounce. Somewhere about '65, a similar storm of hail occurred in Herefordshire, but the shape of the stones was different, each stone being largest in the centre, and



Hailstone.—Actual size. Section. Side view of broken stone.

diminishing to the circumference, resembling not a cart-wheel but an oyster. Some of the largest of these latter stones weighed an ounce.

South Leigh Vicarage, Witney, Oxon. ARTHUR EAST.

THE USE OF HAND TELESCOPES.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In the article "The Use of Hand Telescopes in Astronomy" in this month's Knowledge it is said that in order to increase the power of the instrument it is desirable to remove the lens next but one to the eye end. I have tried this with my telescope, which is a three-draw one, $1\frac{3}{4}$ in. object glass, and found the result tolerably satisfactory.

However, a much better plan is to remove the third lens, *i.e.*, the next but one to the object glass, the result was a surprisingly good one, every part of the field of view available for distinct vision, and the magnifying power about half as large again.

The holding and steadying of a small telescope out of doors is a great trouble even for ordinary use, and always a failure when observing celestial objects. So I got a clip made with a screw attached to it, by means of which I can steady the telescope, and move it freely in every direction.

I also have an astronomical telescope with a 3 in. object glass and a power of 100 diameters, and I find it often useful to remove the inner one of the two lenses which form the eyepiece. The field of view becomes smaller, but the magnifying power is very much increased thereby, and it enables me to see comparatively very small objects on the moon, and even divide the rings of Saturn.

Walthamstow, February 10th, 1902. M. Hare.

[I do not agree with Mr. Hare as to the great advantage to be attained by removing the third lens from the eye end—the next but one to the object glass—though the field is better than when the lens next but one to the eye end is removed. But the advantage of using some means of steadying the telescope is very great. Only, though this is but a verbal criticism, it could scarcely then be described as a "hand telescope."—E. Walter Maunder.]

A METHOD OF GENERATING ACETYLENE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The following method of generating acetylene in small quantities, which other boys and myself have used for some time in the Chemical Laboratory, at Mill Hill School, may be of interest to readers of Knowledge.

Place a few lumps of calcium carbide in a six ounce flask or Woulff's bottle, and cover them with methylated spirits. If diluted hydrochloric acid (1 : 2 water) be slowly dropped into the bottle by means of a stoppered funnel, a steady flow of acetylene gas is evolved, which can be collected, like hydrogen, over water.

The equation is—

$$Ca\,C_2 + 2\,H\,Cl = Ca\,Cl_2 + C_2\,H_2.$$

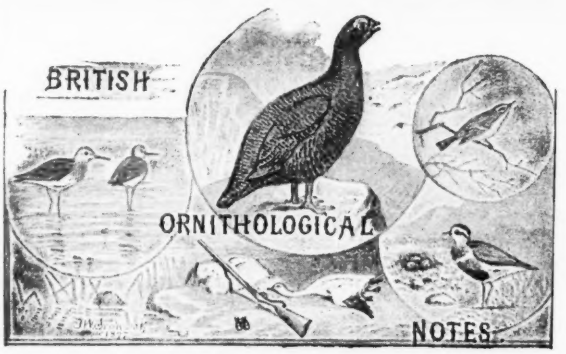
The advantages of this method as compared with that given in text-books (dropping water upon dry calcium carbide) are—

(1) A steady even flow, completely under control, instead of a rapid, brief evolution;
(2) A liquid mass of calcium chloride left, easily washed out of the bottle, instead of a hard cake of slaked lime.

It was not found practicable to keep the calcium carbide under alcohol for any length of time, as the mixture slowly evolved acetylene.

It is possible that the method may be of practical utility for cyclists' lamps, although the use of acid might necessitate some alteration in the material of these.

Mill Hill School, N.W. R. Knowles.



Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Possible Breeding of the Eared Grebe in Oxfordshire (*Ibis*, January, 1902, p. 165).—Mr. O. V. Aplin writes to the *Ibis* with regard to a pair of Eared Grebes which were shot on a large pond near Bloxham on September 19th, 1899. Mr. Aplin gives reasons for supposing that these birds may have remained to breed in England, and that they were not merely migrants.

Nutcracker in Herefordshire (*Zoologist*, January, p. 25).—Mr. H. E. Forrest records that a Nutcracker was obtained in September last near Hereford. In view of the irruption of the Siberian form of the Nutcracker into Western Europe in the autumn of 1900 (*see* Knowledge, 1900, p. 256; 1901, pp. 117 and 281), it would be interesting to know if this specimen was of the slender-billed Eastern form.

King-Eider in Fifeshire (*Zoologist*, January, p. 27).—Mr. B. B. Riviere records that a male King-Eider was shot on a moor in Fifeshire on June 15th, 1899. This Arctic bird seldom visits our islands.

Tengmalm's Owl in Suffolk (*The Field*, February 1st, p. 177).—Mr. F. W. Frohawk here gives an account of two specimens of Tengmalm's Owl which were picked up in an exhausted state at the end of last October in Suffolk. One of the birds was picked up by Captain Lawrence Grubbe on the beach at Southwold on October 30th. The other bird was found in the gardens of the Grand Hotel in the same town probably about the same date. Both birds have been kept alive, and are remarkably tame; but neither give any indications of having been in captivity. Tengmalm's Owl is a rare visitor to the British Islands, and most of the records have been from the Eastern Counties during the autumn or winter. This Owl is an inhabitant of the pine forests of northern regions, but it is also found in the pine-clad mountains of the south; and it migrates to a considerable extent during the autumn and spring.

⁂ *During the absence from England of* Mr. Harry F. Witherby, *who has started on an Ornithological Expedition to South-West Persia, these Notes will be conducted by* Mr. W. P. Pycraft, *to whom all communications should be addressed at the Natural History Museum, Cromwell Road, London, S.W.*

Astronomical.—From measurements made at the Lick and Yerkes Observatories, Prof. Barnard has deduced the following values for the diameters of planets and satellites:—

	Miles.		Miles.
Mercury	2,965	Pallas	304
Venus	7,713	Juno	120
Mars, equatorial ...	4,352	Vesta	239
Mars, polar	4,312	Jupiter, equatorial ...	90,190
Ceres	477	Jupiter, polar	84,570

	Miles.		Miles.
Jupiter, Satellite I. ...	2,452	Saturn, polar	69,780
Jupiter, Satellite II. ...	2,045	Saturn, Satellite Titan	2,720
Jupiter, Satellite III.	3,558	Uranus, equatorial ...	35,820
Jupiter, Satellite IV....	3,345	Uranus, polar	33,921
Saturn, equatorial ...	76,470	Neptune	32,900

A rough attempt to determine the total light of the stars by direct observation has been made by Prof. Simon Newcomb, who is inclined to regard this quantity as among the most important fundamental constants of astrophysics. The methods of observation were extremely simple, consisting chiefly of comparing sky illumination with the image of a star of known magnitude diffused into a disc by a suitable concave lens, and reduced by means of dark glasses when necessary. It was found that the total light of all the stars is about equal to that of 600 stars of zero magnitude, with a probable error of one-fourth of the whole amount. A positive correction, however, is more probable than a negative one, and the number may possibly be greater than 800. From statistics relating to the numbers of stars and nebulæ, it will be remembered that Mr. Gore concluded that the total light was equal to 589 stars of zero magnitude.

We learn from Bulletin No. 14 of the Lick Observatory that two oval nebulous rings surrounding Nova Persei were photographed as far back as March 29th, 1901, although the plate was only exposed for ten minutes as compared with the ten hours which now appears to be necessary. The rings were then quite small, but it is considered that the later rings may be regarded as having been produced by expansion outwards from the Nova. Assuming the identity of the earlier and later forms, the daily radial rate of motion is found to be 2″·62 in the south-west quadrant, and 3″·00 towards the north. At this rate the nebulous matter would have been coincident with the Nova on February 16th or 17th, and some of it might be expected to reach the solar system in about 250 years if the same rate of expansion is maintained, supposing that there is actual translation of the nebulous material.—A. F.

BOTANICAL.—The question of the systematic position of the Nymphæaceæ—whether they should be included in the Dicotyledons or the Monocotyledons—has already been discussed by several botanists. It is brought forward again in a paper by Mr. H. L. Lyon, which appears in the *Minnesota Botanical Studies*, Series 2, Part V., where he records his "Observations on the Embryogeny of *Nelumbo*." In Bentham and Hooker's system the Nymphæaceæ are placed in the Ranales, between the Berberidaceæ and the Sarraceniaceæ. Mr. Lyon shows that *Nelumbo*, both in its anatomy and embryogeny, conforms to the type of the Monocotyledons; that there is only one cotyledon, the two fleshy lobes of the embryo, described by some botanists as cotyledons, really arise through the bifurcation of the originally single cotyledon; and finally, that the order to which it belongs should be included in the Monocotyledons, in the series Helobiæ, which includes *Potamogeton*, *Alisma*, *Butomus*, &c. Referring to the subject in the January number of the *American Naturalist*, Prof. D. H. Campbell points out that the Lesser Celandine (*Ranunculus Ficaria*) has only one cotyledon, and that the Ranunculaceæ, resembling in their flowers those of the Alismales, are amongst the anomalous Dicotyledons.

The origin of the stipules in *Liriodendron*, represented by the well-known tulip-tree of our gardens, is the subject of a paper in the *Bulletin of the Torrey Botanical Club*, of September, 1901, by Mr. E. W. Berry. The writer has examined a great number of leaves of *L. tulipifera*, and taking into account the leaf of a fossil species recently described by Dr. A. Hollick, and the leaves of allied genera of Magnoliaceæ, supports Dr. Hollick's opinion that "the large fugacious stipules of our living tulip-tree might represent former leaf-lobes, which, becoming separated, formed basilar lobes, then winged petioles, and finally the modern stipules."—S. A. S.

ZOOLOGICAL.—On the evening of Friday, January 7th, Professor E. Ray Lankester, Director of the Natural History Branch of the British Museum, delivered at the Royal Institution a lecture on the okapi, illustrated by a life-sized coloured sketch of that remarkable mammal. The relationship of the okapi to the giraffe and the extinct *Helladotherium* and its allies was fully discussed.

Allusion has been already made in these columns to the splitting-up of the puma into a number of so-called species. Recently Mr. E. A. Mearns (*Proc. Washington Academy*, Vol. XIV., p. 137) has followed the same course in the case of the jaguar. Undoubtedly different local forms and phases of both the jaguar and the puma do exist, and, if it be thought desirable, there can be no objection to indicating them by sub-specific or varietal names. When, however, it comes to calling them species the case assumes a very different aspect, for we are then in danger of losing sight of the all-important fact that these two types of cat range over a very large portion of the American continent (the puma much farther than the jaguar). In return for this loss, we gain—nothing, if not worse than nothing. It is a case of losing sight of the wood for the trees, and the sooner this practice of excessive species-making on the part of specialists is discouraged, the better it will be for the true interests of natural history. No advantage whatever can be urged in favour of the practice, while there is much that can be said against it.

Had space permitted, we should have called attention at an earlier date to a very interesting paper by Miss D. Bate on the mammals discovered by herself in a cave in the Wye Valley near the Forest of Dean, which appeared in the *Geological Magazine* for last year. The special interest connected with these remains is that they are chiefly those of bats, insectivores, and rodents, and that many of the latter belong to Arctic and Alpine types at present unknown in Britain. The species include the Norwegian and the banded lemming, the pica, the northern vole, the Alpine vole, and the Continental field-vole, as well as several still existing in Britain. Hitherto, almost the only evidence of the former presence in Britain of the Arctic and the Alpine vole has been afforded by remains from Somersetshire and Wiltshire.

The theory that the horns of the big-horn wild sheep *(Ovis canadensis)* act the part of megaphones in conveying sound to the ears of their owners, which was discussed at a recent meeting of the Linnean Society, has formed the subject of correspondence in the columns of *The Field*. One observer writes very strongly against the likelihood of the theory being true, and some of his arguments will be found very difficult to controvert. It is a pity, however, that he uses the term *helix*, when he means *pinna*, or *conch*.

In a paper on a collection of mammals from Shendi, on the Upper Nile, published in the December issue of *Novitates Zoologicæ*, Mr. W. E. De Winton names a spiny mouse *Acomys witherbyi*, in honour of Mr. H. F. Witherby, by whom the type specimen was collected near Khartum. A new species of gerbil (*Gerbillus watersi*) is likewise named in the same communication.

With the exception of a few forms which entered North America during the Pliocene and Pleistocene epochs, the

great extinct edentates allied to *Megalotherium* and *Mylodon* have hitherto been considered characteristic of South America, where they appear to have died out within the historic period. Monsieur Grandidier has, however, recently described the leg-bone of what appears to be another member of the same group from the superficial deposits of Madagascar, under the name of *Bradytherium madagascariense*. Assuming, as seems probable, that these gigantic edentates originated in the southern hemisphere, the present specimen, if its affinities be rightly determined, affords evidence of a former land connection between Madagascar and South America, and thus supports the view that the latter continent was at one time in connection with Africa.

Notices of Books.

"The Stars: A Study of the Universe." By Simon Newcomb. Progressive Science Series. (Murray.) 6s.—We opened this book with pleasurable anticipations; we closed it with something little short of amazement. Prof. Simon Newcomb is a deep thinker, a laborious worker, a most eminent astronomer. But the readers of this book would never divine that it is by such an author. It is superficial, and not worthy of the name it bears on its title page. And yet, in his preface, Prof. Newcomb says that he did not consider this task an easy one; he had "to study whole chapters of observations and researches on some minute branch of the subject, and condense their gist into a few sentences; now to search volumes of periodicals, perhaps in vain, to find who was first in the field, or what result some investigator had reached; now to do justice to the respective works of students of the same subject; now to recast or rewrite passages in the light of some newly published research." We can find hardly any trace of all this minute and deep research in the work. All the information therein contained Prof. Newcomb must surely have known; must have picked up in the ordinary course of his astronomical duties; must have breathed in almost with the air of his ordinary astronomical life. When any investigation begins to get interesting we are blocked by the stereotyped phrase, "the reasoning is too abstruse and the results too mathematical to be easily presented in the present work." But this elision of all reasoning that may not be plain to the dullest, sometimes renders Prof. Newcomb's own meaning obscure. For instance, in giving Myers' working out of the system of the double star Beta Lyrae, he says, "Beta Lyrae consists of two bodies, gaseous in their nature, which revolve round each other so near together as to be almost in contact. They are of unequal size. Both are self-luminous . . . . . This theory receives additional confirmation from the fact shown by the spectroscope, that these stars are either wholly gaseous or at least have self-luminous atmospheres." On the surface it would appear as if Prof. Newcomb imagined that the stars were in general solid or liquid bodies, or that they shone by reflected light. The sense of disappointment which the book inevitably produces is, however, almost entirely due to its falling so much below the high reputation of its author. Had it been written by someone whose acquaintance with the science was merely literary, there would have been much in it to praise. And even as it is, the last three chapters must be excepted from the strictures pronounced on the book as a whole, as Prof. Newcomb has taken in them a much more serious view of his task, and they are consequently on a higher level than the greater part of the work.

"History of Geology and Palæontology to the End of the Nineteenth Century." By Karl Alfred von Zittel, Professor of Geology and Palæontology in the University of Munich. Translated by Maria M. Ogilvie-Gordon, D.Sc., Ph.D. (Walter Scott.) 6s.—In 1899 Prof. von Zittel's "Geschichte der Geologie und Paläontologie" appeared as a volume of 870 pages, closely printed in the now archaic German type. Mrs. Gordon's translation, under the auspices of the Contemporary Scientific Series, puts in the hands of all readers a record of progress and discovery which is of interest to workers and thinkers far outside the special lines of geology and palæontology. The book has, however, been reduced in bulk, and this has involved the removal of the very valuable lists of works referred to by von Zittel, which conclude each chapter of the original.

A reference to the original is desirable on account of the introduction by the translator of phrases and sentences which undoubtedly modify the work. We are firmly of opinion that such changes should always be made within brackets or in footnotes. What we want to know is how von Zittel, a dispassionate author of singular reserve and judgment, regards this or that movement, or this or that influence, at work in helping on our science. Von Zittel himself seldom, however, allows his own opinions to obtrude themselves; hence the words "feine Beobachtung und logische Schärfe," "von seltener Originalität," or, on the other hand, "von geringer Wichtigkeit," have from him a meaning far above the phrases of ordinary controversy. But this fact makes it especially undesirable to import similar phrases into his "translated" work; and we may regret, from this point of view, even the fine passage on Hutton inserted by Mrs. Ogilvie-Gordon on page 72. The chapter on the Triassic Period suffers especially from changes of this kind; and subtle little adjectives creep in, and even accusations of carelessness, tending to the discredit of one of the most dignified members of the Viennese school, in contrast with his brethren in Bavaria.

The author himself is partly responsible for some points which may be rectified in the next edition. In so comprehensive a treatise the titles of books may occasionally go astray, as when "Felsarten" is written for "Gesteine," in a reference to Zirkel on page 330, and "Lithographia Würceburgensis" for "Lithographiæ Wirceburgensis specimen primum," on page 18. We have, however, "*Das Flötzgebirge Würtembergs*," "Pennant's *Book of Travel*"—a title that it would be difficult to trace in a library—and other slips, some of which are due to the unfortunate practice adopted by the translator, and occasionally even by von Zittel, of giving the titles of memoirs in a language other than that used by their authors. When some of these titles are translated from English into German and back into English, the possibility of error is apparent. As an example, we suspect that Carpenter's "Introduction to the Study of the Foraminifera" is meant to be referred to on page 383; the title as given is a modified translation of a general phrase written by von Zittel.

The translator's intimate knowledge of German, and her own wide range of geological work, have equipped her well for a task involving very considerable labour. We hence find amazingly few slips in nomenclature—the "phosphorus beds," on p. 420, should be "phosphorite" or "phosphate" beds, and on p. 73 "carbonic acid" is said to have become "converted under this pressure into a granular substance resembling marble." On p. 243, "diatoms" are substituted incorrectly for the "Algen" of the original; the organisms somewhat vaguely discussed by Weed are filamentous forms.

Where notable departures from the original have been occasionally made, we might, perhaps, have expected the introduction of new matter in the form of notes or addenda here and there. On p. 424 or 541, a reference to Dubois and *Pithecanthropus* would seem natural in the year 1901; it is high time for the geologist, and even for our cautious Geheimrat, to accept responsibility for dealing in a systematic way with the precursors of the human race. On p. 337, again, the earnest persistence of English petrographers, notably Judd, in urging that geological age was practically valueless in any scheme of classifying igneous rocks, is not done justice to when we are told that "Rosenbusch (!) removed the final judgment of petrography from the laboratory to the field." The phrase is almost as emphatic in the original; and German writers, at any rate, may easily be excused for believing that the introduction of the microscope threatened the "natural history" aspect of petrography in other countries as completely as in their own. Von Zittel's review, however, of the relations between Prof. Rosenbusch and MM. Fouqué and Lévy is one of the best illustrations of his extraordinary grasp of the range of geological research.

Another small correction which it seems extremely difficult to introduce, even into English treatises, is the substitution of the English chemist's name, Sonstadt, for Thoulet (p. 333) as the first who used the solution of mercury and potassium iodides in refined specific-gravity determinations. On p. 334, "Bréon" is a slip, in the original, for "Brauns," who proposed the use of methylene iodide. In conclusion, let us be grateful for a handy book which has justly taken the place of all previous attempts to deal with the history of geology.

"ELEMENTS OF BOTANY." By W. J. Browne, M.A. Fifth edition. Illustrated. (Heywood.) 2s. 6d.—This new edition of Mr. Browne's useful little primer is considerably enlarged and abundantly illustrated. The greater portion of the book is occupied with descriptive detail. This is well done, and the numerous illustrations which are provided are helpful. We fancy the book is intended for the use of students entering for the examinations of the Science and Art Department or other bodies. Were it not so the beginner might find the subject matter more attractive and more living if there were less structural botany and more natural history of plants. We find in the book very little relating to life-histories, or to the relation of plants to their environment. The interesting subject of the dispersal of fruits and seeds is dismissed in a page and a half, while the history and geography of plants on this earth are not touched on at all. Botanical examination papers do not usually err on the side of undue attention to this side of the subject; yet in the Science and Art and London University papers, given at the end of the book, we find elementary questions relative to the dispersal of seeds and the characters of maritime plants that could hardly be answered from this book. Mr. Browne's primer is, however, eminently adapted for its purpose; but we would hope that, in the course of time, elementary examination papers on the subject may deal more with the botany which the child may learn out of doors and by its own observation.

"THE PROCESS YEAR-BOOK, 1901: AN ILLUSTRATED REVIEW OF THE GRAPHIC ARTS." Edited by W. Gamble. (Penrose & Co.)—The Annuals, of which this is the seventh, published by Messrs. Penrose, evidence the increasing attention given by the public to book-illustration by the sustained high quality of their reproductions. The various beautifully finished blocks printed in one tint or in three colours, which adorn this Annual, cannot fail to afford great pleasure as examples of British workmanship. Numerous articles are given, explaining processes and detailing methods by which present results have been reached. These, though very brief, are written by authorities on the several subjects, and adequately fulfil the purpose of an excellent Year-book.

"NAUTICAL ASTRONOMY." By J. H. Colvin, B.A. (Spon.) 2s. 6d. net.—A useful little book, covering the entire course required in the Board of Trade Examination for Extra Master, as well as for the ordinary examinations of that body. It will be found of service also to the navigating officer as a book of reference.

"A RECORD OF THE PROGRESS OF THE ZOOLOGICAL SOCIETY OF LONDON DURING THE NINETEENTH CENTURY." Edited by the Secretary.—More than half this book is devoted to a list of names of Fellows of the Society. The remainder forms a brief, too brief we consider, but very interesting yearly record of the progress of the society. It deals chiefly with important exhibits at the gardens, erection of new buildings, births at the gardens, and a few notes on the society's publications.

BOOKS RECEIVED.

Chemistry for Photographers. By Charles F. Townsend, F.C.S., F.R.P.S. (Dawbarn & Ward.) Third Edition. Illustrated. 1s. net.

Solar Constant. By Frank W. Very. (Washington: Weather Bureau.)

On the Relation of Phyllotaxis to Mechanical Laws. Part II. *Asymmetry and Symmetry.* By A. H. Church. (Williams & Norgate.) 5s.

Certain Personal Matters. By H. G. Wells. (Fisher Unwin.)

Farm and Home Year Book. Third Edition. Illustrated. 1s.

Exemplary Novels. Vol. I. By Miguel de Cervantes. Edited by H. Buxton Forman. (Gowans & Gray.) 1s. net.

Text-Book of Geology. By Albert Perry Brigham, A.M., F.G.S.A. (Hirschfeld.) 6s. net.

The Discovery of the Future. By H. G. Wells. (Fisher Unwin.) 2s.

The Procession. February. (Los Angeles, Cal.: Heald.) 10 cts.

Report of Weather, Sevenoaks, 1901. (W. W. Wagstaffe.)

The Aspirate. By the Rev. Geoffry Hill. (Fisher Unwin.) 3s. 6d. net.

Geology. By Sir Archibald Geikie, F.R.S., &c. (Macmillan.) Illustrated. 5s.

Poultry Management on a Farm. By Walter Palmer, M.P. (Constable.) Illustrated. 1s.

Jamaica. (Geo. Philip & Son.) 6d. net.

Selection of Subject in Pictorial Photography. By W. E. Tindall, R.B.A. (Iliffe.) Illustrated. 3s. 6d. net.

Journal of the Society of Comparative Legislation. December, 1901. (Murray.) 5s. net.

Plant Structures. By John M. Coulter, A.M., PH D. (Hirschfeld.) 6s. net.

Plant Relations. By John M. Coulter, A.M., PH.D. (Hirschfeld.) 6s. net.

C. G. S. System of Units. By J. D Everett, M.A., D.C.L., F.R.S., F.R.S.E. (Macmillan.) 5s.

Nature's Mysteries. By A. P. Sinnett. (Theosophical Publishing Society.) 2s. net.

Practical Retouching. By Drinkwater Butt, F.R.P.S. (Iliffe.) 1s. net.

English Public Opinion after the Restoration. By Gerald Berkeley Hertz, B.A. (Fisher Unwin.) 3s. 6d. net.

Practical Exercises in Magnetism and Electricity. By H. E. Hadley, B.SC. (LOND.). (Macmillan.) 2s. 6d.

Early Work in Photography. By W. Ethelbert Henry, C.E. (Dawbarn & Ward.) Illustrated. 1s. net.

Atlas of Practical Elementary Zootomy. By G. B. Howes, LL.D., F.R.S. With Preface by the late Right Hon. Prof. T. H. Huxley, P.C., F.R.S. (Macmillan.) 10s. 6d. net.

British Tyroglyphidæ. By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S. (Ray Society.) Illustrated.

WING-LINKS.

By E. A. BUTLER, B.A., B.SC.

IN the present paper I propose to deal with the different devices that are to be found in the structure of four-winged insects, for linking together the fore and hind wing on the same side during flight, so as to produce an increase of power in the simultaneous use of the two pairs of wings. The extensive order Diptera, therefore, consisting, as it does, wholly of flies which have only one pair of wings fully developed, will be outside our present purview. And so equally will the Coleoptera, or beetles, for, although at first sight they appear to have two pairs of wing-like appendages, yet, as only one of these is used for the actual accomplishment of flight, the insects are, for all practical purposes, dipterous. Putting these two great orders on one side, therefore, we find that the rest, with the exception of a few small groups which are apterous, are all four-winged, and use both pairs in flight. Out of this enormous assemblage of four-winged creatures, however, our attention will be mainly concentrated on two orders, the Hymenoptera and the Lepidoptera, for, with few exceptions, it is in these two alone that we find any special structures such as are indicated above.

But, before considering these, there is one group of insects that, for an opposite reason, merits notice because of the entire independence with which the wings work. These are the dragon-flies, the wings of which differ in several important characters from those of most other insects. The power of flight in dragon-flies varies very much. While the larger kinds are extremely powerful fliers, and when "hawking" for their prey can go sailing along at a high rate of speed, the smaller and more fragile species have to content themselves with a comparatively weak sort of flutter. In all the species, however, the fore and hind wing on each side are independent of each other; they do not touch, and though they move simultaneously, there is a certain space left between their edges through which the air can pass as the wings move up and down. Again, throughout the Insecta, the secondary, or hind-wings, are generally of a more delicate texture than the primaries, and often smaller in area, but, if not actually smaller, they yet have to be folded up and tucked away under the primaries when the insect assumes the position of rest. In all these points dragon-flies differ from most other insects. The two pairs of wings are approximately of the same size, and of similar texture, and in the attitude of rest the secondaries are not folded and packed away beneath the primaries. A large dragon-fly when hunting its prey on the wing must, of course, be able, if it is to be

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a successful hunter, rapidly to alter its course and adapt itself to the sudden movements of its quarry. These insects are, in fact, adepts at "dodging," and however fast they may be flying, can instantly wheel at a sharp angle, or even make a complete *volte face*. It can hardly be doubted that the independence of the wings is an important factor in these movements, so that, while a certain amount of power is lost to the stroke by the fact that the wings are not linked together, yet this is compensated for by the ability to wheel suddenly, which is brought about by the absence of such union.

In this country we have only a few other insects with wings constructed like those of dragon-flies; the chief of these are the lovely lace-wing flies, which are amongst the most delicate and fairy-like creatures we possess. But as they have only a very feeble power of flight, they need not concern us further on the present occasion.

We pass now to those insects that possess wing-links of some kind or other. Amongst these the Hymenoptera take the first place. The order contains bees, wasps, ants, sawflies, and that host of parasitic insects known as ichneumon flies. These creatures have two pairs of membranous wings, the anterior of which are much larger than the posterior. Each wing, whether primary or secondary, is by itself long and narrow, and in proportion to the size of the body, offers but a small surface to the action of the air, and hence would not have much sustaining power. But the anterior edge of the hind-wing has nearly the same outline as the posterior edge of the fore-wing, so that, when in use, the two fit pretty accurately together, one behind the other. This alone, however, would not be of much good, as the two wings would be easily liable to be separated in flight, and thus break the force of the stroke. But there is a beautiful arrangement which keeps them in position relatively to one another, and thus enables them to offer to the resistance of the air what is practically an unbroken surface equal to their combined areas.

The wings of a hornet, or failing these, of a humble bee, or wasp, will show this arrangement admirably. For a certain distance, beginning rather more than half-way along the anterior edge of the hind-wing, there is a series of hooklets bent obliquely outwards, upwards, and backwards. Fig. 1 shows the arrangement of these in a

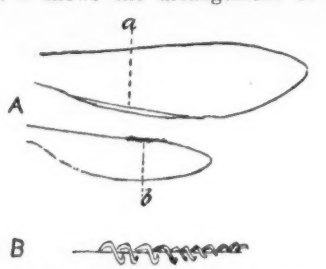


Fig. 1.—A, Wings of Hornet. *a*, Fold on Fore-wing. *b*, Hooks on Hind-wing. Magnified two diameters. B, Portion of Hooked Margin. Much more highly magnified.

hornet's wing. The number of hooklets varies with the insect; for example, the hornet has 29, and the hive bee about 23, humble bees have from 19 to 26, according to species and sex, and so on. In general the number appears to range between one and two dozen, but the ichneumon flies have fewer, while the giant Sirex, or tailed wasp, the largest hymenopterous insect we possess, has upwards of 50.

Along the hinder edge of the fore-wings, in the part immediately opposite the hooks, the membrane is strengthened and bent under, forming a sort of trough or gutter. When the wings are expanded, the hooklets of the hind-wing hang over the edge of this trough, and thus the two wings are firmly linked together, so that any movement of the one drags the other with it. And this is advantageous in more ways than one. For in the Hymenoptera, as in insects generally, the chief muscles of flight are those attached to the fore-wings; they are far more bulky and powerful than those belonging to the other pair, hence the linkage compensates for the lack of muscular force in the hind-wings, and enables them to partake of the superior strength of the primaries. Further, it will be seen that the arrangement by which the hooks of the hind-wings lay hold of a fold *above* them and *under* the fore-wings, brings about a still closer union between the wings during the down stroke when the greatest power is required for propelling the insect, whereas if they were attached in the opposite way, there would be a greater tendency for them to loosen their grip, and so defeat their purpose.

The hooks are simply modified hairs, and the hornet shows a gradual change of form in them as we pass along the series, from the completely hooked and strongly gripping clasper at one end, to the scarcely bent but stout hair-like objects at the other, which have obviously very little clasping power left. The rest of the wing-margin at both ends of the series is bordered by simple hairs of the ordinary type. Of course these hooks, under the most favourable circumstances, are extremely small, and need the use of a microscope for their examination. But their power is easily demonstrated in a fresh specimen of the insect; for if, by grasping the fore-wing between thumb and finger or with forceps, we move it in any direction, we find that the hind-wing of the same side accompanies it in all its movements.

In the Lepidoptera, the order which contains the butterflies and moths, the arrangement is of quite a different character. In the butterflies, there is no special apparatus to link the wings together, but their united action in the down stroke is assured by the fact that the fore-wing at its inner edge laps considerably over the hind one. The depression of the one, therefore, carries the other with it without difficulty. In moths there are two different plans for bringing about the same result. Suppose we take such a creature as the Ghost Moth (*Hepialus humuli*). This is a very common insect, and is remarkable as having a completely different coloration in the two sexes; the male is entirely white above and smoky beneath, while the female is of a tawny yellow with reddish markings on the fore-wings. Near the base of the fore-wing at its inner edge in either sex, a small projecting lobe is seen, of a membranous nature, but stiff, and furnished with a fringe of long hair (Fig. 2). The points of attachment of the two wings to the thorax in this insect and its allies, are so situated as to leave a small gap at the base of the wings when they are spread for flight. This allows the above-mentioned lobe to get beneath the margin of the hind-wing, while the rest of the fore-wing, as usual, overlaps; thus the wing is held, as it were, in a clip, and the united action of the two is aided to some extent, though not very efficiently.

Fig. 2.—Right Fore-wing of Ghost Moth. *a*, Jugum.

This kind of link is found in two families of moths only, viz., that of the Swifts, to which the Ghost Moth belongs, and a family of extremely minute moths which rejoice in the rather cumbrous name of *Micropterygidæ*. As these minute insects are known only to the learned in such matters, they have no popular name, and we must perforce

use their long-winded family title. While the Swifts are for the most part soberly coloured, the *Micropterygidæ* are some of the most brilliant insects we possess, and if only they were magnified to the dimensions of the Swifts, they would be the admired of all observers. The ground colour of the fore-wings is usually a deep shining golden bronze, and this is crossed in some cases with bars of polished purple or silver. Many of them are common enough in early summer in flowers or on the leaves of young trees, but they are so small that they usually escape notice, and a lens is necessary to make out fully their beauties. Both these groups of insects possess this clasping lobe, and though at one time placed far apart from one another in systematic classification, they are now often associated together because of this and other peculiarities, and many entomologists believe that they represent the most ancient and primitive type of Lepidoptera to be found throughout the world.

To observe the other method of linkage that prevails in the Lepidoptera, almost any kind of moth may be used. We might, for example, take such an insect as the Common Yellow Underwing (*Triphæna pronuba*), a moth that is so abundant as to be within the reach of everybody. Suppose we take first of all a male specimen; if we separate one of the hind-wings we see proceeding from a point very near its place of articulation, a strong, stout, curved bristle (Fig. 3, *a*), which is delicately grooved throughout its

FIG. 3.—Right Hind-wing of Yellow Underwing. *a*, male; *b*, female.

length, and ends in a finely drawn-out point. This is only half the apparatus, and to find the other part we must go to the fore-wing. Here, attached to the first of the great nervures that radiate over the surface of the wing, just below the anterior boundary, and not far from its base, is what looks like a swelling or excrescence. To see its true

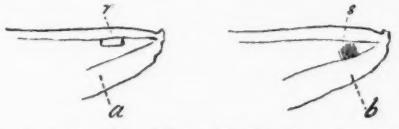


FIG. 4.—Underside of Base of Right Fore-wing of Yellow Underwing. *a*, male; *b*, female; showing Retinaculum, *r*; Tuft of Scales, *s*. Magnified 2 diameters.

form, it will be necessary to remove the scales with which it is thickly covered; a little brushing with a camel's hair brush will easily do this, and then it appears as a longitudinal flap or coil of stoutish membrane projecting from the nervure, and with its free end bent under in such a way as to leave a passage between itself and the general surface of the wing (Fig. 4, *a*). If we now examine the moth with its wings in position as if for flight, we see that the bristle of the hind-wing passes through the loop on the fore-wing, like a thread through the eye of a needle, and thus the two wings are linked together (Fig. 5).

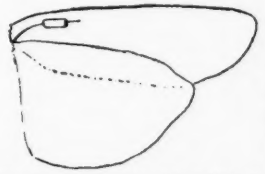


FIG. 5.—Underside of Left Wings of Male Yellow Underwing, showing Spine passing through Retinaculum.

Next let us take a female, and deal with it in the same way. We find now that instead of a single bristle there are three somewhat weaker ones (Fig. 3, *b*), one of which is very fine, and all are bent at a sharper angle than in the male insect. When we examine the fore-wing, we find that the loop-like retinaculum, as it is called, has entirely disappeared, and instead of it we find a bunch of scales pointing in the opposite direction, and springing, not from the nervure before-mentioned, but from the next one farther down the wing (Fig. 4, *b*). Examining the wings in position, we find that the cluster of bristles on the hind-wing is thrust through and entangled in this bunch of scales, and thus the two wings are held together to some extent, but of course not so effectually as in the male insect.

There is a slight variation from this type in the day-flying Burnet moths. These brilliant insects, with their glossy greenish-black fore-wings relieved by crimson spots or streaks, and with crimson hind-wings, form some of the prettiest ornaments of our grassy hillsides as they fly from flower to flower in the brightest sunshine. In place of the customary loop on the fore-wing we find them provided with a sort of pocket into which the tip of the bristle is thrust. In the long-winged and swift-flying Hawk-moths, which are for the most part crepuscular in their habits, the linking apparatus reaches its highest development, in accordance with the exceptional vigour and speed of their flight. In the Poplar Hawk-moth, however, which is the most sluggish of the group, the apparatus is quite rudimentary, and this, again, is in accordance with its habit of carrying its hind-wing, when at rest, in such a way that its front margin projects beyond the fore-wings, for this would obviously prevent the bristle, if it were present, from being passed through the loop.

There is another very curious variation in a group of small moths called "Pearls." One of the commonest of these is a long-legged insect generally found amongst nettles; it has glossy yellowish-grey wings, marked with wavy lines, and showing a certain amount of iridescence, whence its common name "Mother of Pearl" (*Botys verticalis*). In this insect and its allies, the male imitates the female in being destitute of the loop, and thrusting its bristle into a tuft of scales.

The difference between the single spine of the male and the group of spines which is characteristic of the female, is more apparent than real. For if the male spine is closely examined under the microscope, it is seen as before-mentioned to be distinctly furrowed, and a transverse section shows that it is made of several spines which have coalesced. Thus both arrangements consist of a group of spines, which in the one case are compacted, and in the other remain distinct.

From this sexual difference one would be inclined to argue that male moths would exhibit a power of flight somewhat superior to that of their partners, and it is certainly true, in some instances at least, that the females are much more sluggish than the males, and when on the wing fly more heavily; but it can hardly be said that this is generally the case in any marked degree, and even if it were so, the greater weight of the body in the female insect might be as effectual a cause of retardation as the less close linkage of the wings. And further, in a few instances, such as the Drinker and Oak Egger moths and their allies, the males of some of which are extraordinarily active, flying with great force and speed even in hot sunshine, the wing-links are altogether absent. In these cases, however, the secondaries, by their great development anteriorly, considerably underlie the primaries, and thus no doubt render the spine and loop arrangement unnecessary, if not indeed, impracticable.

XUM

PRESERVING AND MOUNTING ROTIFERA.

By Charles F. Rousselet, *Curator, R.M.S.*

For Note referring to Material, see the Microscopy Column.

There be few observers of pond life who have not felt a keen desire to preserve and keep these small highly-organised sparks of life instead of letting them die and disappear in a few days. For a close study of this group, well preserved type specimens are of the greatest possible assistance and importance, and if such had existed formerly much confusion and inexactitude in their description and classification would have been avoided, particularly in the giving of three or four different names to the same species, which causes so much trouble to the student.

The total absence of type specimens of Rotifers to refer to when required originally led me to attempt to produce them, and it is now over ten years since the first successful experiments at preserving them in a fully extended and natural state were made. My method, although so simple now, took fully three years to work out until the right and most suitable narcotic, fixing agent, and preserving fluid were found. By the use of suitable fixing agents, not only the external shape of Rotifers can be preserved, but also all the internal structure to the minutest anatomical details, such as the striated muscle fibres, nerve threads, vibratile tags or flame cells,. sense hairs, cilia, etc., and frequently important details can be more readily observed than in the living animal.

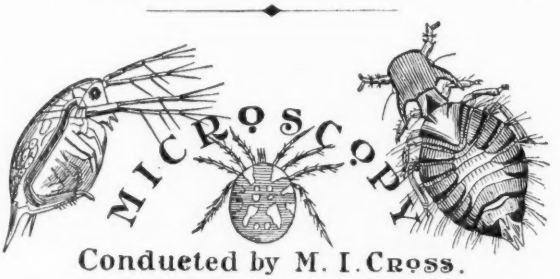
As is well known, no killing agent is sufficiently rapid to prevent the complete retraction of Rotifers, and few other animals can contract into such a shapeless mass when we attempt to kill them by ordinary means, such as poisons, alcohol, heat, etc. It is, therefore, necessary to use first a suitable narcotic, which has been discovered in hydrochlorate of cocaine. As a result of many trials, the best solution for most Rotifers has been found to be the following mixture:—

2 % solution of hydrochlorate of cocaine, 3 parts;
Alcohol (or methylated spirit), 1 part;
Water, 6 parts.

Another narcotic which is also very suitable for Rotifers is a one per cent. watery solution of hydrochloride of eucaine, recommended by Mr. G. T. Harris, for Infusoria and other animals. These narcotics, even so dilute, are not to be used pure, as they would cause the Rotifers to contract at once and not expand again. The principle to be followed throughout is to use the narcotic so weak that the animals will not mind it at first, but continue to expand or swim about freely. After a short time its effect will make itself felt on their nervous system, and then some more of the narcotic may be added, until complete narcotisation is produced, or until the animals can be killed without contracting.

But before the operation of narcotising is begun, it is very necessary to isolate the Rotifers in perfectly clean water. The best way is to pick them up under a dissecting microscope by means of a very finely drawn-out pipette, having a funnel-shaped enlargement at the other end, which is covered with an elastic membrane. This pipette forms a most delicate syphon, by means of which any selected Rotifer can readily be taken up with the least quantity of water, and transferred to another trough or watch-glass full of clean water. This preliminary precaution is necessary, because particles of dirt in the water readily attach themselves to the cilia of dead Rotifers, rendering them unsightly under the microscope. Another advisable precaution is to separate the different species, because most species require a slightly different treatment, and because the small species too readily adhere to the cilia of the large species.

Having then isolated a number of free-swimming Rotifers in a watch-glass half full of perfectly clean water, one drop of one of the above narcotics is added and well mixed. After five or ten minutes, if the animals continue to swim about freely, another drop is added, and so on until the effect of the narcotic becomes visible, and until the motion of the cilia, or the movements of the animals slacken or almost cease, when they are ready for killing. The effect of the narcotic varies very much with different species, some are most sensitive to it, whilst others can stand a considerable quantity for a long time. Some practice and patience are certainly required to find out the right time to kill the different species; no general rule can be given, as the time may vary from 15 minutes to several hours. It is very essential, however, that the Rotifers be still living when the killing fluid is added to prevent post-mortem changes in the tissues which begin at once on the death of the animals. *(To be continued.)*



Conducted by M. I. Cross.

Pond-life Collecting in March.—The same species as those mentioned for February are still to be found and in greater abundance. Some new Infusoria will have made their appearance, such as *Stentor polymorphus*, which will be found covering the rootlets of Duckweed and other submerged plants, *Peridinium tabulatum* and the free-swimming colonies of *Synura uvella*, etc. Then the very minute and beautiful colonies of Collared Monads, *Codosiga umbellata*, and other species of this group may be looked for, attached to the stems of Vorticella trees.

All the Rotifera forming the winter fauna will become very abundant in March, and as the food supply in minute Algae and Infusoria increases, fresh species make their appearance with every rise of temperature. The following additional species may be looked for: *Brachionus angularis; Notholca acuminata, spinifera*, and *labis; Euchlanis oropha; Dinocharis pocillum; Diaschiza lacinulata; Proales decipiens* and *petromyzon; Monostyla cornuta, Diglena forcipata; Rotifer vulgaris.*

Testing Objectives.—To judge decidedly for oneself whether an objective is a good, bad, or indifferent one is a matter that calls for more than ordinary discrimination, and there are but few workers whose judgment as to the merits of any particular lens would be accepted without reservation.

It may almost be said that the microscopist who is capable of judging lenses is born and not made, for while some can almost by intuition give an opinion which will ultimately prove correct at almost the first sight of a favourite object through the objective, others who have had perhaps excellent opportunities of acquiring skill are unable to arrive at a reliable decision. Practice, on proper lines, will however greatly assist in estimating the quality of lenses, and it will be well to enquire what the elements of a good objective are and what tests can be applied to determine without doubt whether or no it is accurately constructed and of good performance.

The qualities of an objective depend particularly on centreing, corrections for chromatic and spherical aberration, and accuracy of manufacture. Beyond these, numerical aperture and initial magnifying power require consideration.

We will assume for our purpose that the objective is made on a good formula and is constructed on rational modern principles such as are adopted by all up-to-date opticians, and proceed to consider the tests that may be applied. For the majority of optical instruments, standards are set, and if the specimen under examination conforms to that standard or is equal to it, it is considered satisfactory, but the microscope

objective has qualities under so many phases, each series of lenses having their own peculiar characteristics, that it is almost impossible to have a standard test for all the qualities, still it would be a most advantageous and desirable consummation if some centre could be arranged where undeniable unprejudiced reports could be obtained concerning objectives. It might be that an objective that was admirably corrected for spherical aberration, well centred and possessing a proper ratio of aperture to magnification would be high in colour when the colour tests were applied; this would not necessarily be a bad or inferior lens, and might be superior to an apochromatic in which the colour correction was perfect, while the spherical aberration was not so well controlled. Tests that are applied to objectives should be as far as possible mechanical ones, that is, such as will admit of but slight error of judgment, but this is only partially possible. For instance, the numerical aperture and initial magnifying power can be determined, the former by means of the Apertometer, and the latter by the regular rules laid down in the text-books. Yet in so simple a proceeding as measuring the aperture, there will frequently be a considerable variation between the results obtained by separate individuals; even this requires not merely care and skill, but a large amount of experience. The only way is to take readings several times and to strike an average for the result. It will, probably, be found that if four readings be taken, the Apertometer pointers will be at a different position on each occasion.

After many years of experience in examining and criticising lenses, I have found nothing so thoroughly satisfactory for getting at the real accuracy of an objective as the "Abbe Test Plate." Its merits are hardly recognised in the manner they should be probably for the reason that microscopists generally are quite, content to take the quality of their objectives for granted and to refrain from splitting hairs over fine details, but no man can be a master of his instrument without being fully conversant with the possibilities or drawbacks which his lenses may possess. *(To be continued.)*

NEW MICROSCOPES.—Messrs. R. & J. Beck have sent a price-list and particulars of the "Imperial" Microscope, a new instrument designed by them for critical work.

It is made in four different models and supplied with both horseshoe and tripod bases. The most complete instrument of the series on tripod foot has special claims to consideration, for it is provided with every convenience that the modern worker with objectives and condenser of high aperture could desire.

All the instruments of the series are fitted with the new two speed fine adjustment to which reference was made in these columns in the January number.

I am just a little doubtful of the expediency of fitting a mechanical stage with the controlling milled heads perpendicular to its surface. In turning them, pressure will be exerted downwards and there would be a natural tendency for the object to go out of focus.

By adopting this method of construction, however, the added convenience of complete rotation to the stage is gained and the plates of the mechanical fittings do not come in contact with the substage condenser, a very desirable consummation.

FORAMINIFEROUS MATERIAL.—The number of applicants for this so far exceeded expectations, that the supply to each one had to be limited considerably. Several readers omitted to send a stamped directed label; a small quantity may yet be had by such on compliance with this condition.

MOUNTING AND PREPARING ROTIFERS.—For the benefit of those readers who may wish to experiment on the lines recommended by Mr. Rousselet, and who may have difficulty in securing the specimens, it may be worth while to mention that both Mr. Bolton, 25, Balsall Heath Road, Birmingham, and Mr. Pearsall, Headmaster, Senior Mixed Board School, Dalton-in-Furness, supply Rotifera in tubes: the former at 1s., and the latter at 1s. 3d. per tube including postage.

The Rev. E. J. Holloway, of Clehonger Vicarage, Hereford, also kindly offers to supply Rotifer material, particularly *philodina*, to readers, in order to further the work of the "practical" scheme. It would be courteous if such as avail themselves of this offer would send a tube with an addressed label bearing stamps for the cost of the return postage.

A lady reader also kindly offers to supply a limited quantity of Mycetozoa.

CONSULTANTS.—In response to the invitation for assistance in the January number, one gentleman has kindly consented to name Diatoms and another to identify micro fungi infesting plants, etc.; if any who feel able to assist in other departments will communicate with me, I shall be glad.

NOTES AND QUERIES.

O. Evans.—The material concerning which you require information has been kindly examined by Mr. A. Earland, together with your drawing, and the following is his report:—"True coccoliths, *i.e.*, the calcareous surface plates of the microscopic alga Coccosphaera have been found in the chalk and in other fossil deposits, but they are of rare occurrence."

The term "coccolith" is, however, very loosely used by geologists for the description of almost any small plate-like perforated body, approximating to the true coccoliths in shape and size.

Mr. Oswald Evans' figures 1—8 and 10, with one possible exception (fig. 9), all belong to well-known forms of these "spurious" coccoliths, which are of frequent occurrence in many fossil deposits. Their nature and origin are quite unknown. One thing only is certain, they have no connection with the true coccoliths, which have an altogether different structure. Presumably they are the remains of some organism or organisms quite extinct and unknown.

The essential feature of a true coccolith is its "double structure." Each coccolith consists of two curved plates (oval in *Coccosphaera pelagica* Wallich, and round in *C. leptopora* Murray and Blackman) united by a central column, which is pierced by a median pore. A true coccolith therefore bears some resemblance to a shirt stud with a hole pierced right through the middle.

Figure 9, though it does not show this double structure, bears some resemblance to a true coccolith (of *C. leptopora*), and might prove to be one. Figures 11 and 12 are rather curious; 11 seems to be a stellate microsclere from a sponge; 12 might be of Radiolarian origin; 19, 20, 21, are certainly sponge spicules, and 22 is probably a sponge sterraster with adventitious perforations.

Rhabdolith is used by geologists in a very wide sense also. Of the Figures 13—18, only two, viz., 15 and 16, *could* be true rhabdoliths, and the detail of the drawing is not sufficient to determine this with certainty.

Figs. 13, 14, 17 and 18 are almost certainly of sponge origin, more or less eroded.

J. Searle, Oporto.—This correspondent has expressed his willingness to supply material towards the success of the practical scheme. He suggests that living in Portugal, there might be some object or series of objects which would be interesting to readers. Also he would be glad to exchange material, etc., with other microscopists. If any readers would like to communicate with this gentleman, I shall be pleased to re-address their envelopes.

F. R. C. S.—Any of the binocular microscopes made by the opticians who advertise in this journal would give you satisfaction. You will find that it is well not to have the binocular body less than 8 ins. long; shorter ones have been made, but they are not nearly so satisfactory. The Wenham, which is the usual kind of binocular, will prove most serviceable; it can always be rendered monocular by sliding the prism out of position, for which provision is made; the light then only passes up the monocular tube. Binocular eye-pieces have never proved really comfortable in the tests that I have made.

J. H. G. inquires if any method is known of mounting Cladocera so as to preserve the transparency. He also suggests that some notes on the preparation and mounting of Entomostraca might prove interesting. Can any readers give information or assist in these matters?

G. Fisk.—Seeing that you have a $\frac{1}{8}$" objective, it is absolutely necessary for you to use an illuminating apparatus, you cannot secure satisfactory results without it. It its absence you are not working your objectives to anything like their full capacity, and you will be surprised at the improvement you will obtain when the condenser is added.

T. Peters.—An article on Microtomes as suggested by you will appear in a month or two.

XUM

A. E. F.—You will find the information you require in an article on "The Specific Gravities of Saturated Solutions of Stains," given in detail in the "Knowledge Diary and Scientific Handbook for 1902." This is published at "KNOWLEDGE" Office and contains a variety of useful information in addition to the diary itself.

C. S. Purcell.—Any of the methods in use for the demonstration of flagella will show those of the *B. Subtilis*. Perhaps the best and easiest is the Pitfield modified by Muir *(vide* page 116 of the last edition, Muir & Ritchie's Manual of Bacteriology).

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEXT RETURN OF HALLEY'S COMET.—As we draw nearer to the time of perihelion passage in 1910, the interest in this object will continue to increase. There is no other comet which has so many important historical associations and whose apparitions can be traced from so remote a period. It was visible in the year of the Norman Conquest, and its first well-recorded appearance through more than nineteen centuries to nearly twelve years before the Christian era. This comet is only perceptible once within the allotted term of human existence, since it revisits the sun every 77 years, and there are very few persons who have lived in the particular period and to the great age necessary to afford them the privilege of viewing the comet at two returns. We may discern that small "Mercury of comets," called after the illustrious Encke, again and again, for its solar visits are repeated at short intervals of 3½ years, but the comet of Halley ordinarily furnishes but one spectacle at most during a lifetime. Since the year 12 B.C. the latter comet has nearly accomplished 25 revolutions, and Mr. J. R. Hind gave some interesting details of its previous apparitions in Vol. X. of the *Monthly Notices* (January, 1850). Its period varies, owing to planetary perturbation, between 74½ and 79½ years, and the revolution now being performed will be one of the shortest if not the shortest known in the history of the comet, for the last perihelion passage occurred in 1835 (November 15th), while the next is predicted for 1901 (May 23), the interval being equivalent to 74 years and 189 days. Dr. D. Smart has furnished some useful particulars in reference to the next return of the comet (*Journal of the British Astronomical Association*, Vol. XII., p. 134-5), and on the assumption that the perihelion will be reached on 1910, May 23rd, has computed an approximate ephemeris, from which are extracted the following positions :—

HALLEY'S COMET, 1910.

Date.	R.A. H.	M.	S.	Dec. °	′	Distance in Millions of Miles.	Apparent Brightness.
Jan. 7 ...	2	29	28	+ 12	42	167	·055
Feb. 8 ...	1	36	24	+ 10	57	195	·060
Mar. 12 ...	1	17	40	+ 11	33	214	·089
April 29 ...	1	5	20	+ 14	59	158	·402
May 15 ...	1	2	40	+ 17	38	112	1·30
„ 31 ...	1	23	20	+ 30	25	47	7·25
June 16 ...	8	29	24	+ 37	28	24	21·00
July 2 ...	11	13	20	+ 3	9	74	1·50
„ 18 ...	11	38	8	− 2	37	130	·33
Aug. 3 ...	11	49	44	− 5	32	177	·12

In December, 1903, the comet will be placed in the region of the Hyades and thereafter traverses Aries and Pisces. There is a meteoric shower connected with it and this should be looked for before sunrise during the first week in May. The meteors are directed from a radiant near η Aquari, which does not rise in the latitude of Greenwich until nearly 2 a.m. on May 4th.

THE LEONIDS OF 1901.—From a number of accounts received from American observers, it seems that a moderately rich display of these meteors was seen. For several hours preceding sunrise on November 15th the rate of apparition was three or four per minute for one observer, while during the period of greatest frequency there were about twice that number. At several of the stations the maximum appears to have occurred at about 11.30 a.m. G.M.T., or four hours after sunrise in England, and this sufficiently explains how it was that the display proved a meagre one as observed in this country. There were about ten times more Leonids seen in America than in England, and it is certain that the earth encountered the denser part of the stream at a time when it could only be observed at places far west from Greenwich. At some of the American stations meteors appeared to be increasingly plentiful in the morning twilight of November 15th, and it seems possible that the real maximum may have occurred even later than the time given above, in which case it could have been witnessed from the Pacific Ocean, but we have no description of it from voyagers in this region. The fact that the shower showed a marked increase in strength as compared with the feeble exhibitions of the few previous years, encourages the hope that a further revival may occur in November next. The parent comet passed through perihelion in the spring of 1899, but the meteors appear to be plentifully clustered along a considerable section of the orbit in rear of the comet. There were showers in 902, 1002, 1202 and 1602, and observers will therefore do well to make observations in the coming November, though the full moon will offer a serious hindrance.

RELATIVE HEIGHTS OF PERSEIDS AND LEONIDS.—The real paths of a large number of meteors have been computed in past years, and especially at those particular periods marked by the occurrence of special displays like the Perseids and Leonids. Our accumulated records are becoming very extensive of the former shower, occurring as it does at a genial season when the skies are often clear, and every year presenting a moderately rich display of long duration. The November Leonids are confined to a more limited interval and are often obliterated by clouds; in some years the display is so feeble that it passes unrecorded. From a comparison of the real paths of Perseids and Leonids it appears certain that the former are rather lower in the atmosphere than the latter, though we have scarcely secured a sufficiently large number of Leonids to institute a fair comparison. The following are the resulting heights, &c., of a number of Perseids and Leonids doubly observed in England during the last fifteen years, and computed by the writer :—

	Height at beginning. Miles.	Height at ending. Miles.	Length of path. Miles.	Velocity per second. Miles.
Perseids	80·3	54·0	42·5	42·2
Number of meteors ...	40	40	39	19
Leonids	84·1	55·9	45·1	49·8
Number of meteors ...	17	17	17	9

The observed velocities of 42·2 and 49·8 miles per second exceed the theoretical velocities (38 and 44 miles), but the discordance may well be induced by errors in the estimated durations of flight.

THE FACE OF THE SKY FOR MARCH.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.50 A.M., and sets at 5.37 P.M. On the 31st he rises at 5.42 A.M., and sets at 6.28 P.M.

The Vernal Equinox occurs on the 21st, when the sun enters Aries, and Spring commences at 1 P.M. The disc of the sun promises little of interest for spot observations.

The Zodiacal Light may be looked for in the west for some two or three hours after sunset.

THE MOON :—

	Phases.	h. m.
Mar. 2	☾ Last Quarter	10 39 A.M.
„ 10	● New Moon	2 50 A.M.
„ 16	☽ First Quarter	10 13 P.M.
„ 24	○ Full Moon	3 21 A.M.

The following are the more interesting occultations visible at Greenwich :—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Mar. 17	26 Geminorum	5·1	9 19 P.M.	136	104	10 16 P.M.	247	209	7 19
„ 18	68 Geminorum	5·0	5 48 P.M.	170	197	6 14 P.M.	211	234	8 15
„ 20	ω Leonis	5·6	8 27 P.M.	106	120	9 45 P.M.	299	297	10 18
„ 22	p^5 Leonis	5·5	11 19 P.M.	148	146	12 24 A.M.	265	251	12 21
„ 29	ν Scorpii	4·5	1 41 A.M.	119	138	3 0 A.M.	265	272	19 0

THE PLANETS.—Mercury is a morning star, having its greatest westerly elongation of 27° 41′ on the 17th, when it rises about three-quarters of an hour before the sun.

Venus is also a morning star situated in Aquarius. She is at greatest brilliancy on the 21st, on which date she rises about an hour and three-quarters in advance of the sun.

Mars is unobservable, being in conjunction with the sun on the 30th at 1 A.M.

Jupiter and Saturn are both morning stars, the former in Capricornus, the latter in Sagittarius, but as they only rise about two hours before the sun, they are not well suited for observation.

Uranus is near the position indicated last month, about 1° north of 44 Ophiuchi. He is in quadrature on the 12th, and stationary on the 27th, rising on the latter date about quarter past one A.M. The great southerly declination of over 23° makes the planet somewhat unsuitable for observing purposes.

Neptune is the only planet that can be observed in the evening. He crosses the meridian shortly after 7 P.M. at the beginning of the month. He is making a short looped path in Gemini on the confines of Auriga, Taurus and Orion; this is shown by the diagram given last month. The planet can be readily found from the triangle of stars which has a double star for one corner almost 1° south of 1 Geminorum, and it is a little brighter than either of the star pair referred to. The planet can also be picked out by observations some few days apart, but this is becoming more difficult since the planet is at the stationary point on the 10th, after which the motion is again easterly.

THE STARS.—About the middle of the month, at 9 P.M., the position of the principal constellations will be as follows:—

ZENITH . No bright constellations in the zenith.

SOUTH . Cancer and Hydra on the meridian; Gemini high up, *Procyon* and *Sirius*, all a little to the west. Orion is to the south-west, and Leo (*Regulus*) to the south-east high up.

WEST . Taurus, Aries nearly setting, Auriga (*Capella*) high up. To the north-west Perseus, also Andromeda low down.

EAST . Virgo (*Spica* rising), Bootes (*Arcturus*). To the north-east Ursa Major high up, Corona, Hercules and *Vega* low down.

NORTH . *Polaris;* to the right, Ursa Minor, Draco; below, Cygnus, Cepheus; to the left, Cassiopeia.

Minima of Algol will occur on the 10th at 1.26 A.M., on the 12th at 10.14 P.M., and on the 15th at 7.3 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of February Problems.

(P. H. Williams.)

No. 1.

1. R to Kt8, and mates next move.

No. 2.

Key-move.—1. B to B2.

If 1. . . . K × P, 2. B to B5ch etc.
1. . . . K to B3, 2. B to K4ch, etc.
1. . . . Kt moves, 2. B to Kt3ch, etc.

[The "reprinted problem" last month should, of course, have been described as a four-move, not a three-move problem.]

CORRECT SOLUTIONS of both problems received from G. A. Forde (Captain), C. D. Brown, H. S. Brandreth, W. de P. Crousaz, S. G. Luckcock, G. Woodcock, W. Nash, G. W. Middleton, H. H. S. (Teddington), F. Dennis, C. Johnston, Sekots, H. Le Jeune, H. Boyes, Alpha, C. R. Beechey, A. C. Challenger, W. J. Allen.

Of No. 2 only, from H. Myers.

H. Myers.—After 1. R to B3 Black plays Kt to Kt4 and there is no mate.

G. B. Davies.—In No. 1 you have overlooked that the White Knight at B4 is "pinned" by the Black Bishop. In No. 2, after 1. P to K7, Kt to Q6 or K7, White must give check, as the Knight threatens to do the same.

W. Jay.—Much regret to hear your news, and trust that you will be able to compete when the new Solution Tourney begins. At what date would you prefer your year's subscription to KNOWLEDGE to commence.

Whitchurch.—Your solution of No. 1 (January) was received too late to acknowledge. After 1. Kt to K2ch, Kt × B, 2. R to R5ch is not mate, as the Kt can interpose.

W. J. Al'en.—Yes, "three" was a misprint for "four." Your suggested solution by 1. Kt to Kt6 was fully dealt with last month. Black saves himself by obtaining a stalemate position, playing 1. . . . P to R7, and 2. . . . P to R8 (becoming a Bishop), while White has to block the King's Pawn by 3. Kt to K5. This device constitutes the main idea of the problem, which is otherwise worthless, except for the key.

TOURNEY PROBLEMS RECEIVED.—"Satis," "Nemo saltat sobrius."

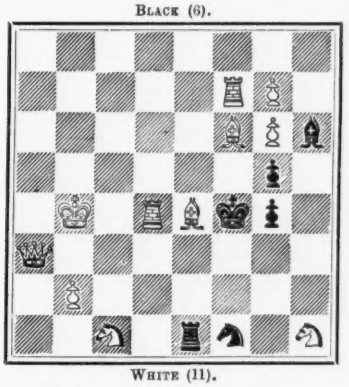
PROBLEMS.

No. 1.

By A. F. Mackenzie.

[First prize in *Brighton Society* Tourney.]

BLACK (6).



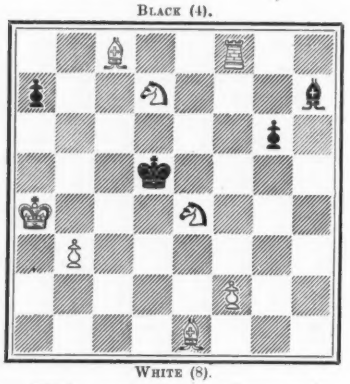
WHITE (11).

White mates in two moves.

No. 2.

By E. G. B. Barlow.

BLACK (4).



WHITE (8).

White mates in three moves.

CHESS INTELLIGENCE.

An International Chess Tournament is now in progress at Monte Carlo. There are twenty competitors, Dr. Lasker, who now holds a mathematical post at Owen's College, Manchester, and Messrs. Blackburne and Burn being the most notable absentees. A feature of the tournament is the return of Dr. Tarrasch to public play. The score will be given next month.

A Collection of Seven Hundred Chess Problems, by Mrs. W. J. Baird, is announced for publication this month by Messrs. Sotheran & Co. The diagrams will be printed in colours, and the volume will contain a portrait of the author. The edition will be limited to 500 copies, the price being 10s. 6d. net.

THREE-MOVE PROBLEM TOURNEY.

1st Prize, One-and-a-Half Guineas; 2nd Prize, Fifteen Shillings; 3rd Prize, "Knowledge" free for 12 months.

The Conditions are as follows:—

1. Each competitor may send not more than one three-move unconditional direct-mate problem (diagrammed).

2. Competing positions must be original and unpublished.

3. Each problem must be accompanied by a motto and full solution, with a sealed envelope containing the composer's name and address.

4. Competing positions much reach Mr. C. D. Locock, Netherfield, Camberley, England, on or before April 10th, 1902.

5. The Chess Editor reserves the right of excluding manifestly impossible, unsound, or inferior positions.

6. The adjudication will be partly by solvers and partly by the Chess Editor.

All solvers who solve correctly every problem will be entitled to vote on their merits. The six or eight problems thus selected will then be adjudicated on by the Chess Editor, whose decision will be final.

A SOLUTION TOURNEY will commence in the May number. Full particulars will be given next month; in the meantime it may be stated that the winner will hold for 12 months a Silver Challenge Trophy, which will become his property should he win it three years in succession, or four years altogether. Second and Third Prizes will also be given, viz.: 15s., and KNOWLEDGE for one year respectively.

The Challenge Trophy consists of a silver Castle on an ebonised pedestal, the whole standing $7\frac{1}{2}$ inches high; the silver portion being 6 inches high. The Trophy is adorned with shields for the inscription of the title and winners' names.

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